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THE HEDERELLOIDEA, A SUBORDER OF PALEOZOIC CYCLOSTOMATOUS BRYOZOA

By Ray S. Bassler

The middle and upper Paleozoic strata of North America contain many incrusting, tubular, corallike organisms usually classified as aberrant cyclostomatous Bryozoa. *Hederella*, *Reptaria*, and *Hernodia* are the best-known genera, each represented by a few previously described species some of which have been identified from such widely separated horizons and localities that their names have little stratigraphic significance. The care of large collections of these fossils accumulated in the United States National Museum during the past 30 years led me to take up their study and, in 1934,[1] to propose the name Hederelloidea as a new order of the Cyclostomata, since the typical bryozoan ancestrula was observed in a number of the species. With the present-day recognition of the Cyclostomata as an order, the Hederelloidea becomes subordinal in rank. At present all the six known genera are classified under a single family—Reptariidae Simpson, 1897.

The earliest known forms of cyclostomatous Bryozoa occur in the lowest Ordovician (Buffalo River series) of Arkansas, where several species of *Crepipora* Ulrich, 1882, of the suborder Ceramoporoidea occur. This suborder expands rapidly, particularly in the Devonian and Mississippian periods, with the very abundant development of *Fistulipora* and its allies, but so far as known becomes extinct with the close of the Paleozoic. In the Chazyan, following the Buffalo

[1] Proc. Geol. Soc. America for 1933, p. 346, 1934.

River series, the Cyclostomata are represented also by typical examples of the suborder Tubuliporina, with *Stomatopora*, *Corynotrypa*, *Proboscina*, and *Berenicea* abundant until the Middle Silurian, where a few species occur. In the Middle Devonian appeared the last Paleozoic representatives of Tubuliporina, comprising a single species of *Corynotrypa* from France and one from Ontario. Then in early Mesozoic times species of this suborder reappear in large numbers, forming the predominating Bryozoa throughout this era and continuing in less abundance throughout the Cenozoic and into Recent seas. Curiously enough the range of the Hederelloidea occupies the interval from the Silurian to the Permian, where the Tubuliporina are either very rare or entirely absent. The relations of the lower Paleozoic to the post-Paleozoic Tubuliporina, therefore, become as interesting a question as those of the Hederelloidea to the Tubuliporina in general.

Close study of the American Hederelloidea reveals a considerable number of species, not all of which are described in this paper. A typical *Hederella* from the Middle Devonian of Australia is also herein described, and comments are made upon species of the several genera known to occur in Europe, especially in the Eifel Devonian,[2] and in the Bohemian Silurian and Devonian.[3] Furthermore, only the species with incrusting zoaria belonging to the genera *Hederella*, *Reptaria*, *Hernodia*, and the new genus *Hederopsis* are treated here. In general these species usually have the appearance of giant examples of *Stomatopora* or *Proboscina*, this resemblance being emphasized by the same bulblike ancestrula noted in some of them. However, the Hederelloidea differ, first, in that the walls are less perforate than in the Tubuliporina; second, each zooecium is separate and not merged in a general crust; third, lateral budding occurs with probably a perforated plate of separation between the zooecia, represented at the surface as a distinct suture line; and fourth, the zooecial aperture is transversely elliptical and terminal, equaling the width of the tubes. This assemblage of characters seems to justify the suborder.

Closely resembling the Hederelloidea and occurring in practically the same geologic range are the Auloporidae, including the Moniloporidae of Grabau. This family, externally very similar but containing still larger tubular organisms, is now placed with the corals, although its systematic position requires further study. A ready method of distinction from the Reptariidae is that the Auloporidae have terminal gemmation instead of lateral budding with no line of separation at the surface, circular orifices, and thick imperforate walls.

[2] Solle (Gerhard). *Hederella*, eine amerikanische Bryozoen Gattung im rheinischen Unterdevon., Senckenbergiana, vol. 19, pp. 15–21, 1937. (*H. rhenana* and *H. applicata*, new species.)

[3] Prantl, Ferdinand. Revision of the Bohemian Paleozoic Reptariidae (Bryozoa), Acta Musei Nationalis Pragae, vol. 1 (B), No. 6, pp. 73–84, pl. 4, 1938.

The discrimination of the Reptariidae is difficult because a single species presents so many variations in growth. Zoaria growing upon smooth organisms exhibit the size of zooecia and method of branching and budding characteristic for the species, but when, as in many cases, the host presents an uneven, often rough surface, the aspect of the zoarium is considerably changed. Age also has its effect, for the youthful zoarium may appear so different from older examples of the same species that numerous specimens are necessary to determine the true specific limits. Fortunately the measurements as to size of zooecia and angle of branching seem to be fairly constant when averages are considered.

For convenience of description, the following terms are employed in this paper: The *zoarium* commences with a bulblike *ancestrula*, from which the initial *zooecial tube* emerges to give rise by lateral budding, alternating to the right and the left, to the primary branch. This, therefore, consists of individual *zooecia* springing from about the middle of the side of the preceding tube so that apparently a continuous central tube appears to be present. Then after a certain distance characteristic for the species, one of the tubes, branching off at a definite angle, continues to bud in that direction and forms a new branch, which later on will repeat the process until finally the entire zoarium is produced, made up of primary, secondary, and even later branches. Thus, the angle of branching of the zoarium may be distinguished from the angle at which the individual tubes bud, and branching and budding, although based upon the same phenomenon, should be discriminated. With these distinctions in mind, the specific characters then comprise the angle and interval of zoarial branching, the angle and frequency of budding of the individual tubes, the length and width of the tubes, the number of tubes occurring along a branch in a definite distance, their rate of expansion, and their surface ornamentation. The measurements are computed as follows: The diameter of a tube is taken at its distal end, the length of a zooecium is that of a normal bud from a branch, and the number of zooecia in a given length is measured along the same side of a regularly developed branch. The bibliography of this suborder is not large, and it is believed that all references to the literature are cited in the course of this paper.

The Paleozoic Cyclostomata as well as the Trepostomata in most instances form solid calcareous colonies, grouped together as stony Bryozoa. Special care is necessary in illustrating these Bryozoa, and many articles even of recent date have been published with wholly inadequate illustrations. I have devoted much time to the subject of proper illustration of such fossils, and a grant from the Penrose Fund of the Geological Society of America has enabled me to prepare

the illustrations for much unpublished work on the stony Bryozoa. The present contribution is the first to appear under this grant. Most of the type specimens herein described are the property of the U. S. National Museum.

The general characters of this suborder and its genera are described below. Then follow in order the descriptions of species, faunal lists showing geological and geographical distribution, and finally a table of measurements for use in the separation of species.

Order CYCLOSTOMATA Busk

Suborder HEDERELLOIDEA Bassler, 1934

Zoarium usually incrusting but sometimes rising into solid branches composed of tubular zooecia with perforated walls derived from a bulbous ancestrula, as in typical Cyclostomata. Zooecia of individual tubes, budded from the lateral wall of the preceding zooecium, the ends of each separated by a plate, probably perforated; apertures transversely elliptical and terminal equaling the diameter of the zooecial tubes.

Family REPTARIIDAE Simpson, 1897

Family characters as for the suborder.

Range.—Middle Silurian to Mississippian.

Genus HEDERELLA Hall, 1881

Zoarium attached to various foreign organic objects and rarely to pebbles or other inorganic substances, branching, consisting of a tubular axis composed of the earlier part of successive zooecia from which the zooecia bud laterally, alternately to right and left; tubes annulated transversely and finely striated longitudinally; apertures terminal, transversely elliptical (fig. 14, A, B).

Genotype.—Alecto canadensis Nicholson, 1874. Middle Silurian to Mississippian.

Genus HERNODIA Hall, 1881

Zoarium as in *Hederella* but consisting of linear series of elongated club-shaped zooecia with no central tubular axis, budding alternately from about the middle of the sides of preceding zooecia; each zooecium gives rise to one or more daughter zooecia (fig. 14, *C*).

Genotype.—H. humifusa Hall, 1881. Upper Silurian, Devonian.

Genus REPTARIA Rollé, 1851

Zoarium incrusting, formed of regularly dividing parallel-edged branches, composed of short, cylindrical, annulated zooecia of equal length, in contact but not coalescing along their sides and proceeding in the plane of their host laterally upward from a median line and then gently outward. Gemmation takes place at the initial portion

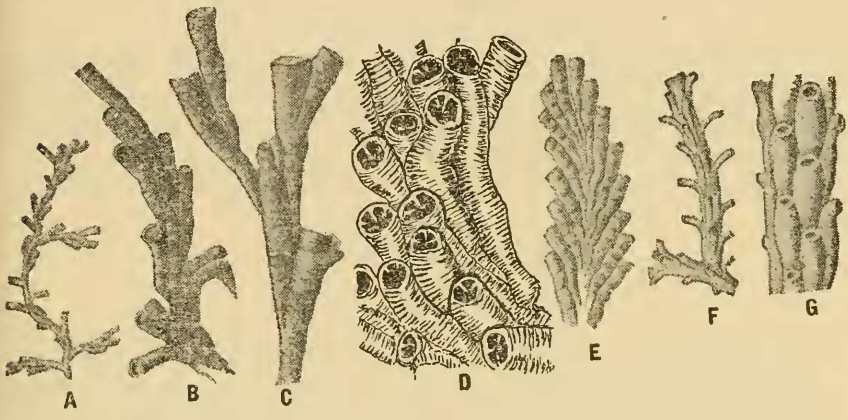


FIGURE 14.—GENERA OF REPTARIIDAE

A, B, Hederella Hall, 1881: *A*, Portion of the incrusting zoarium (× 2) of a typical species, *H. filiformis* (Billings, 1859), illustrating budding at angle of 45° and branching at nearly right angles; *B*, *H. parallela*, new species (× 8), in which the tubes bud at such a low angle as to remain practically in contact.

C, Hernodia Hall, 1881: Genotype, *H. humifusa* Hall, 1881 (× 4); the incrusting zoarium is characterized by linear club-shaped zooecia, each budding at an acute angle from about the middle of the preceding tube.

D, Hederopsis, new genus: Sketch of genotype, *H. typicalis*, new species (× 4), showing carina within the tubes.

E, Reptaria Rollé, 1851: Small portion of genotype, *R. stolonifera* Rollé, 1851 (× 4); the parallel-edged branches formed of closely adjacent tubes, arising alternately from the basal portions of the preceding ones, characterize the genus.

F, Clonopora Hall, 1881: Fragment (× 4) of genotype, *C. semireducta* Hall, 1881, illustrating erect cylindrical growth.

G, Cystopora Hall, 1881: Genotype, *C. geniculata* Hall, 1883 (× 6), much resembling *Clonopora* but differing in the terminal constriction of the zooecial tubes.

(All figures except *D* after Hall and Simpson, 1887.)

of the preceding opposite zooecium so that no central line of tubes occurs as in *Hederella* (fig. 14, *E*).

Genotype.—R. stolonifera Rollé, 1851. Upper Silurian, Devonian.

HEDEROPSIS, new genus

Similar to *Hederella* in form of zoarium and general zooecial structure, but within the tubes on their basal side there occurs a well-defined longitudinal septum, joined by transverse partitions, outlining two rows of compartments (fig. 14, *D*).

Genotype.—H. typicalis, new species. Middle Devonian.

Genus CLONOPORA Hall, 1881

Zoarium ramose, branches cylindrical, consisting of elongate tubular zooecia cohering for part of their length then bending outward and becoming free; apertures terminal, not contracted, arranged in rings or spirally around the branch (fig. 14, *F*).

Genotype.—C. semireducta Hall, 1881. Lower and Middle Devonian.

Genus CYSTOPORA Hall, 1881

Zoarium cylindrical, ramose, consisting of tubular flask-shaped zooecia cohering for the greater part of their length; distally the zooecia bend outward becoming free and much contracted; apertures transversely elliptical, subterminal (fig. 14, *G*).

Genotype.—C. geniculata Hall, 1881. Lower and Middle Devonian.

DESCRIPTIONS OF SPECIES

Genus HEDERELLA Hall, 1881

Hederella Hall, Trans. Albany Inst., vol. 10, p. 194, 1883 (abstract, p. 194, 1881).—Hall and Simpson, Pal. New York, vol. 6, p. 26, 1887.—Miller, North Amer. Geol. Pal., p. 308, 1889.—Simpson, 14th Ann. Rep. State Geol. New York, 1894, p. 599, 1897.—Grabau, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 178, 1899.—Nickles and Bassler, U. S. Geol. Surv. Bull. 173, p. 21, 1900.—Prantl, Acta Mus. Nat. Pragae, vol. 1 (B), p. 75, 1938.

Nicholsonia Davis (part), Kentucky Foss. Corals, pt. 2, 1885 (name proposed but not defined). [Genotype: *N. canadensis* Davis (not Nicholson) = *Hernodia davisi* and *Hederella contortilis*, new species.]

Thamnocoelum Počta, Syst. Silur. Boheme, vol. 8, p. 208, 1894. (Genotype: *T. fruticosum* Počta, 1894.) Silurian of Bohemia (see pl. 12, fig. 2).

This widespread genus is so prolific in species that it is convenient to subdivide it into four groups: (1) The *Hederella canadensis* group, which includes the numerous species with small zooecia and the rather simple structure of the genotype; (2) the *H. alpenensis* group, in which the branches divide frequently and the zooecia bud regularly and alternately; (3) a group characterized by *H. magna*, where the tubes, although large, are comparatively short and rapidly expanding with wide-open apertures; and (4) the *H. parallela* group wherein the zooecia remain so long in contact as to appear parallel. In each of these groups the branching and budding and size of tubes are fairly constant in the initial and mature stages, but old examples often develop such a dense network around the oldest part of the zoarium that the real specific characters can be seen only in the younger portions of the colony. Bohemian species of this genus not considered in the present article are *H. fruticosa* (Počta) 1894, *H. formosa* Prantl, 1938, and *H. obscura* Prantl, 1938.

HEDERELLA CANADENSIS GROUP

Zoarium consisting of a single, narrow, tubular axis formed of the initial portions of successive zooecia branching at rather regular angles and distances, with the zooecial tubes arising one at a time alternately to right and left from about the middle of the side of the preceding one. For comparative purposes the 34 species here described under this group are arranged under four headings: (1) The typical section with 13 species with small zooecia, (2) the ten species grouped around *H. vagans*, with wider unilinear branches loosely subdividing and budding at long intervals, (3) three species with long straight tubes as in *H. blainvillei*, and (4) nine species characterized by *H. thedfordensis*, with a robust zoarium of rather long, wide, frequently budding zooecia.

Hederella canadensis section

HEDERELLA CANADENSIS (Nicholson, 1874)

PLATE 7, FIGURES 2–4

Alecto ? canadensis NICHOLSON, Can. Nat., ser. 2, vol. 7, p. 146, 1874.
Aulopora ? canadensis NICHOLSON, Pal. Prov. Ontario, p. 124, fig. 57a–e, 1874.
Hederella canadensis HALL, Trans. Albany Inst., vol. 10, p. 194, 1883 (abstract, p. 194, 1881); Rep. State Geol. New York 1883 p. 53, 1884.—MILLER, North Amer. Geol. Pal., fig. 483 (p. 308), 1889.—WHITEAVES, Contr. Can. Pal., vol. 1, p. 210, pl. 28, figs. 8, 8a, 1891.—SIMPSON, 14th Ann. Rep. State Geol. New York, 1894, pl. 25, figs. 12, 13, 1897.—GRABAU, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 178, fig. 77, 1899. Not *Hederella canadensis* HALL and SIMPSON, Pal. New York, vol. 6, pl. 65, figs. 1–7, 14, 16, 1887 (includes various species from the Hamilton at York, N. Y., as follows: Figures 1, 6, and 8=*H. filiformis* (Billings, 1859); 2=*H. thedfordensis* n. sp.; 3=*H. parallela* n. sp.; 4=*H. cirrhosa* Hall, 1881; 5, 7=*H. delicatula* n. sp.; 14=*H. vagans* n. sp.; 16=*H. contortilis*).

Specimens from both the Onondaga limestone and the Hamilton shales were included among the original figured types of this species, but the original of figure 57c of Nicholson's illustration is here selected as the holotype, as it appears to be the most accurate drawing and, moreover, agrees exactly with a topotype in the U. S. National Museum collections identified by Nicholson himself. As thus restricted, *H. canadensis* is a slender, delicate species occurring usually as molds in the siliceous Onondaga fossils of Ontario, but gutta-percha squeezes furnish excellent representations of the surface. The zoarium incrusts cup corals and other objects and consists of a narrow tubular axis, which branches at rather regular intervals of about 5 mm. at an angle of 30°, from which the zooecia are given off alternately to the right and left at distances averaging 1.2 mm.; measuring on the same side of the axis 3 to 4 zooecia occur in 5 mm. The zooecial tubes are indistinctly annulated, are about 0.2 mm. in diameter and 0.7 mm. long, with the aperture terminal, transversely oval; they arise from the

branch at such an acute angle that they often remain in contact with it. Although much like *H. cirrhosa* Hall, 1881, *H. canadensis* has smaller dimensions.

Occurrence.—Middle Devonian (Onondaga): Port Colborne, Ontario (Decewville limestone); vicinity Ann Arbor, Mich. (drift).

Plesiotype.—U.S.N.M. Nos. 52961, 87898.

HEDERELLA SILURIANA, new species

PLATE 13, FIGURE 3

The type and only known example of this, the oldest known species of the Hederelloidea, incrusts a brachiopod, *Protothyris didyma* (Dalman), from the Silurian of Gotland, and at first sight seems to represent a well-developed *Stomatopora*. Closer examination shows it is an infrequently branching *Hederella* with short zooecial tubes of about the same dimensions as in *H. rectifurcata*. The type consists of several overlapping branches, but a single one exhibits branching at a right angle and 2 mm. intervals, with very short zooecial buds 1 to 2 mm. long, 0.4 mm. in diameter, arising 3 mm. apart on the same side of the branch at nearly a right angle. More careful comparison with *H. rectifurcata* will show other differences, such as the extreme angularity of branching and budding in the latter.

Occurrence.—Silurian (Gotlandian): Island of Gotland (probably Klintehamn).

Holotype.—U.S.N.M. No. 93954.

HEDERELLA COLBORNENSIS, new species

PLATE 7, FIGURE 1

Associated with the genotype, *H. canadensis*, at Port Colborne and closely simulating it in size, this new species differs in the more straggly arrangement of the branches and the longer and more infrequently budding zooecia. Here the general zooecial arrangement is much as in *H. vagans*, but all of the dimensions are smaller and the zooecia themselves consist of elongated tubes budding from the main axis in a decided curve at an acute angle. Branching irregular but usually about 4 mm. apart at 60° angle. Length of zooecial tubes about 1.25 mm.; width 0.3 mm.; 4 to 5 zooecia in 5 mm.

Occurrence.—Onondaga (Decewville limestone): Port Colborne, Ontario.

Holotype.—U.S.N.M. No. 87986.

HEDERELLA CONCINNA, new species

PLATE 7, FIGURES 10–15; PLATE 15, FIGURE 2

A delicate species resembling *H. canadensis* in general size and zoarial form, but differing in that the zooecial tubes are longer and arise more regularly from the axis at shorter distances and at such a

low angle (30° or less) that they frequently remain in contact with it. Closer measurements show that the diameter of the tubes is 0.3 mm., with 5 to 6 tubes in 5 mm. Length of zooecial tubes about 0.75 mm.; branching somewhat irregular but often at right angles and at intervals of more than 5 mm.

Occurrence.—Middle Devonian: Erie County (cotype) (Wanakah shale), 3 miles west of East Bethany (cotype) and Livingstone County (Centerfield shale), near Pavilion, 1½ miles south of East Bethany, and Darien (Tichenor limestone), and Kashong Creek (Ludlowville shale), all in New York; Thedford (cotype) and Arkona, Ontario (Widder shale); Bell quarry, 2.1 miles east of Bay Shore, Emmet County (Traverse-Gravel Point limestone) and 1½ miles northeast of Bay View (Traverse-Petoskey formation), Mich.; Sandusky, Ohio (Onondaga-Columbus limestone).

Cotypes.—U.S.N.M. Nos. 54078, 87955, 87957, 87961, 87884.

HEDERELLA PARVIRUGOSA, new species

PLATE 6, FIGURES 12–14

This new species shows considerable resemblance to *H. concinna*, but comparison of the illustrations magnified on the same scale indicates that it is larger in all its dimensions. The branches subdivide at intervals of about 7 mm. when the growth is normal, in which case 4 zooecia occur in 5 mm. The zooecia are short, 1 mm. long and 0.35 mm. wide, expand rapidly and arise regularly at angles of about 45°, often remaining free the greater part of the length.

H. regularis is a related form but has smaller zooecial measurements, with branching more frequent and more regular. *H. arachnoidea* is similar but has less rapidly expanding zooecia.

Occurrence.—Middle Devonian: Elma (cotype) (Wanakah shale), Skaneateles Lake (Ludlowville shale), Moscow (cotype) (Moscow shale), Pavilion (Tichenor limestone), and 1½ miles southeast of East Bethany (Kashong shale), all in New York; Thedford (cotype), Marshs Mill, 2½ miles east of Arkona, Ontario (Widder shale); 2½ miles southwest of Sylvania, Ohio (Silica shale); 3½ miles west of Charlestown, Ind. (Silver Creek dolomite); and abandoned shale pit, Alpena Portland Cement Co., Alpena County, Mich. (Traverse-Upper Ferron Point formation).

Cotypes.—U.S.N.M. Nos. 10858, 54120, 78158, 87917–87921.

HEDERELLA REGULARIS, new species

PLATE 8, FIGURES 1, 2

Although apparently closely related to *H. concinna* in its microscopic measurements, this species may be separated by the great regularity not only in the branching of the zoarium but also in the size

and arrangement of the zooecial tubes. The type specimen, which incrusts a *Cystiphyllum* over a space of at least 10 sq. cm., shows the same unusually regular arrangment throughout the single zoarium of which it is composed. Zooecial tubes short, slightly curved, emerging at an angle of about 45°, very delicately lined transversely, and with terminal transverse oval aperture slightly raised. Zoarial branching at intervals of 3 to 5 mm. Zooecial diameter 0.15 mm., length 0.6 mm.; 6 tubes in 5 mm. Compared with other species, *H. regularis* is not so delicate as *H. delicatula* and is smaller than *H. parvirugosa.*

Occurrence.—Hamilton group: Thedford, Ontario (holotype) (Widder shale); 3 miles west of East Bethany, N. Y. (Centerfield shale).

Holotype.—U.S.N.M. Nos. 26575, 94558.

HEDERELLA ARACHNOIDEA Clarke, 1900

PLATE 13, FIGURE 7

Hederella arachnoidea CLARKE, Mem. New York State Mus., vol. 3, No. 3, p. 61, pl. 9, fig. 11, 1900.

Only the type specimen, a zoarium incrusting the inner surface of a trilobite glabella, has been found, but it shows relationship to the *H. canadensis* group, differing from other small species in the considerable length of its branches and the regularity with which the zooecia arise alternately from the branch. Length of zooecia 1.3 mm., width of zooecia 0.25 mm.; branching at intervals of about 5 mm., often at nearly right angles, with zooecia arising at angle of about 35°; 4 zooecia in 5 mm.

H. concinna is a related species but has smaller dimensions. *H. parvirugosa* is perhaps still closer but its zooecia are shorter, more rapidly expanding, and wider at their extremity.

Occurrence.—Oriskany sandstone: Becraft Mountain, near Hudson, N. Y.

Plastoholotype.—U.S.N.M. No. 93957.

HEDERELLA CIRRHOSA Hall, 1881

PLATE 6, FIGURES 1–8

Hederella cirrhosa HALL, Trans. Albany Inst., vol. 10, p. 194, 1883 (abstract, p. 194, 1881); Rep. State Geol. New York for 1883, p. 53, 1884.—HALL and SIMPSON, Pal. New York, vol. 6, p. 277, pl. 65, figs. 12, 13, 1887.—SIMPSON, 14th Ann. Rep. State Geol. New York, 1894, pl. 25, figs. 10, 11, 1897.—WHITEAVES, Contr. Can. Pal., vol. 1, pt. 5, p. 381, 1898.—BASSLER, *in* Cleland, Wisconsin Geol. Nat. Hist. Surv., Bull. 21, sci. ser. 6, p. 57, pl. 6, figs. 4, 5, 1911.—STEWART, Geol. Surv. Ohio, ser. 4, Bull. 32, p. 26, pl. 1, fig. 18, 1927.

Hederella canadensis HALL and SIMPSON (part), Pal. New York, vol. 6, pl. 65, fig. 4, 1887.

This graceful species incrusts crinoid stems, cup corals, and other organisms where its branches cover several square centimeters. The zoarium consists of a narrow single tubed main axis from which slightly curving zooecial tubes, 1½ mm. long and 0.3 mm. wide, emerge alternately and regularly at an angle of 30° to 45° at intervals averaging 1 mm. Branching of the main axis occurs at long intervals usually, but in one regularly growing specimen 7½ mm. was the average distance. Two or three zooecia occur in 5 mm. measuring in the usual manner, although this number is doubled when, as in rare cases, all the zooecial budding occurs on the same side of a branch.

H. concinna is a related but more delicate species, while *H. canadensis* has also smaller and shorter zooecia.

Occurrence.—Middle Devonian: West Bloomfield, York, and Skaneateles Lake (Ludlowville shale), Athol Springs, etc., Erie County (Wanakah shale), 1½ miles south of East Bethany (Tichenor limestone), 3 miles west of East Bethany (Centerfield shale), and Pavilion (Moscow shale), all in New York; Arkona and Thedford, Ontario (Widder shale); 3½ miles west of Charlestown, Ind. (Silver Creek dolomite); and Partridge Point, 3 miles south of Alpena, Mich. (Traverse-Partridge Point formation).

Plesiotypes.—U.S.N.M. Nos. 54105, 87905–87910, 87956.

HEDERELLA FILIFORMIS (Billings, 1859)

PLATE 1, FIGURES 1–6′

Aulopora filiformis BILLINGS, Can. Journ., new ser., vol. 4, p. 119, 1859.—NICHOLSON, Pal. Prov. Ontario, p. 42, figs. 11a, b, 1874.

Hederella filiformis HALL, Trans. Albany Inst., vol. 10, p. 194, 1883 (abstract, p. 194, 1881); Rep. State Geol. New York, 1883, p. 54, 1884.—HALL and SIMPSON, Pal. New York, vol. 6, p. 278, pl. 65, figs. 9–11, 1887.—WHITEAVES, Contr. Can. Pal., vol. 1, p. 211, pl. 29, fig. 1, 1897.—GRABAU, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 179, fig. 77a, 1899.—BASSLER, *in* Cleland, Wisconsin Geol. Nat. Hist. Surv., Bull. 21, sci. ser. 6, p. 55, pl. 6, figs. 1–3, 1911.

Hederella canadensis HALL and SIMPSON (part), Pal. New York, vol. 6, pl. 65, figs. 1, 6, 8, 1887.—GRABAU and SHIMER, North Amer. Index Foss., p. 120, fig. 179a, 1907.—STEWART, Geol. Surv. Ohio, ser. 4, Bull. 32, p. 28, pl. 1, figs. 16, 17, 1927.

Although several distinct species were first figured under this name, there is little doubt that the specimens here selected for illustration agree in all respects with Billings' original *Aulopora filiformis*. These, like the original type are incrusting *Spirifer mucronatus thedfordensis*, where they occur in zoaria of several centimeters in diameter composed of a unilinear axis, 0.5 mm. wide, branching almost at right angles at intervals of about 5.5 mm. Short, slightly curved, rapidly expanding zooecial tubes about 1 mm. long arise at an angle of about 45° on alternate sides of the branch; surface of tubes delicately annulated; apertures transversely oval, opening upward; 4 zooecia in 5 mm. measuring along a straight branch.

Of the hundred or more specimens studied, this species maintains its specific characters rather well, differences in its appearance being due to the uneven surface it may incrust, or to old-age conditions in which a regular mat is formed as in other species of the genus.

Occurrence.—Middle Devonian: Arkona and Thedford and vicinity, Ontario (Widder shale); 18-Mile Creek and Athol Springs (Wanakah), Pavilion and 1½ miles south of East Bethany (Tichenor limestone), 1½ miles southeast of East Bethany (Kashong shale), and 3 miles west of East Bethany (Centerfield shale), all in New York; 2½ miles southwest of Sylvania, Ohio (Silica shale); Milwaukee, Wis. (Milwaukee limestone); Rockport quarry (Upper Bell shale), Rockport quarry and abandoned shale pit, Alpena Portland Cement Co. quarry (Upper Ferron Point formation), 7-Mile Dam and ½ mile southeast of 4-Mile Dam, Alpena County (Norway Point formation), 1½ miles northeast of Bay View and 1.6 miles north of Norwood, Charlevoix County (Petoskey formation), ¼ mile northwest Bolton, Alpena County (Alpena limestone), all in Traverse group of Michigan.

Plesiotypes.—U.S.N.M. Nos. 13754, 57526, 71769, 87914, 87915.

HEDERELLA BROWNAE, new species

PLATE 1, FIGURE 13

This new species, based upon a well-preserved specimen incrusting a *Spirifer* and collected by Dr. Ida Brown, of the University of Sydney, is interesting as the first record of the suborder in Australia, and in its close resemblance to the American species *H. filiformis* Billings. The Australian species differs, however, in the greater length of the zooecia (1.6 mm.) and the shorter interval (3 mm.), and the smaller angle of branching (60°). The abundant American species *H. thedfordensis* is quite similar in zoarial growth, but it has distinctly larger zooecial measurements.

Occurrence.—Middle Devonian: Taemas, south side of Murrumbidgee River, New South Wales.

Holotype.—U.S.N.M. No. 97240.

HEDERELLA ALTERNATA (Hall and Whitfield, 1873)

PLATE 5, FIGURES 1–3

Stomatopora? alternata HALL and WHITFIELD, 23d Ann. Rep. New York State Mus., p. 235, pl. 10, figs. 7, 8, 1873.

Hederella alternata FENTON and FENTON, Strat. and Fauna Hackberry Stage, Upper Devonian, p. 72, pl. 17, figs. 5, 6, 1924.

A species of moderate size for the genus, in which the alternate arrangement of the zooecia in their development along the branches is exceptionally well marked. Specimens growing upon rather smooth brachiopod shells where the normal arrangement of the tubes has

been undisturbed by surface rugosities show that a small bulblike ancestrula is followed by a very short tube, which soon commences to emit branches at right angles to each other at intervals of about 3½ mm., and that these give rise on alternate sides to zooecia, seldom over 1 mm. long, emerging at angles of usually 45°. Four zooecia may be counted in 5 mm., and the usual width of both the zooecia and branches is about 0.35 mm.

Occurrence.—Devonian (Hackberry-Cerro Gordo shale): Rockford, Iowa, and vicinity.

Plesiotypes.—U.S.N.M. Nos. 54081, 65548.

HEDERELLA LINEARIS (Fenton and Fenton, 1924)

PLATE 5, FIGURES 6, 7

Hernodia linearis FENTON and FENTON, Strat. and Fauna Hackberry Stage, Upper Devonian, p. 73, pl. 17, fig. 7, 1924.

Although approaching *Hernodia* in the regularity of its budding, this species seems to be a *Hederella* characterized by its short, broad zooecia arising at regular intervals of 1.25 mm. alternately on the sides of the branch at an angle of 30° or less. Branching of the zoarium also occurs rather regularly at intervals of about 6½ mm. and at angles of about 60°. Measuring along an uncurved branch 3 zooecia occur in 5 mm. Length of zooecial tubes 1.2 mm., width 0.35 mm. The associated *H. alternata* of similar dimensions has less regular branching and zooecia emerging at a higher angle. *H. filiformis* is also similar in size but has very short, broad zooecia and branching more at a right angle.

Occurrence.—Devonian (Hackberry-Cerro Gordo shale): Rockford, Iowa, and vicinity.

Plesiotype.—U.S.N.M. No. 87887.

HEDERELLA CONCINNOIDES, new species

PLATE 11, FIGURE 9

A very slender species related to *H. concinna*, from which it may be separated by its more delicate unilinear branches dividing at angles of about 60° at intervals of 2.5 mm. and emitting zooecia 1 mm. long and 0.15 mm. wide at an equally high angle. *H. delicatula* is also related, but its branches are still more delicate and not so regular, while its zooecia arise at an acute angle.

Occurrence.—Middle Devonian: 2½ miles southwest of Sylvania, Ohio (holotype) (Silica shale); 3 miles west of East Bethany, N. Y. (Centerfield shale).

Holotype.—U.S.N.M. No. 94585.

HEDERELLA DELICATULA, new species

PLATE 11, FIGURES 1–8

Hederella canadensis (part) HALL and SIMPSON, Pal. New York, vol. 6, pl. 65, figs. 5, 7, 1887.

This very delicate but abundant species may be recognized easily by its threadlike zoarium, which, upon sufficient magnification, resolves itself into a main axis giving rise, often at right angles and intervals of about 1.5 to 6 mm., to equally narrow branches from which, as well as from the main axis, the short zooecia arise on alternate sides at angles of about 45°. All the other characters are as in the larger typical species of the genus. Frequent overgrowth of the branches results in a dense mat in which it is hard to trace the arrangement of the tubes. Zooecial tubes are 0.8 mm. in length and 0.15 mm. in width; 4 to 5 zooecia in 5 mm.

This, the most delicate member of the genus, is in marked contrast with such forms as *H. robusta* and *H. reimanni*, yet the zooecial characters of the three are essentially the same except for size.

Occurrence.—Middle Devonian: 18-Mile Creek, etc., Erie County (cotype) (Wanakah shale), 3 miles west of East Bethany, and York (Centerfield shale), 1½ miles south of East Bethany (cotype) and Pavilion (Tichenor limestone), Moscow, Leicester and Kashong Creek (Moscow shale), all in New York; Thedford (cotype) and Arkona, Ontario (Widder shale); 2½ miles southwest of Sylvania, Ohio (Silica shale); Lebanon, Ky. (cotype) (Sellersburg limestone); Milwaukee, Wis. (cotype) (Milwaukee limestone); Falls of the Ohio (Upper Jeffersonville limestone) (cotype); Petoskey Cement Co., Petoskey (Gravel Point limestone), Phelps Quarry (Upper Alpena limestone), and Rockport quarry, Alpena County (Upper Ferron Point formation), ½ mile southeast of 4-Mile Dam, Alpena County (Norway Point formation), Partridge Point, 3 miles south of Alpena (Partridge Point formation), 1½ miles northeast of Bay View and 1.6 miles north of Norwood, Charlevoix County (Petoskey formation), ¼ mile northwest of Bolton, Alpena County, and Thunder Bay quarry, Alpena (Alpena limestone, Dock Street clay), all in Traverse group of Michigan.

Cotypes.—U.S.N.M. Nos. 26574, 50247, 54082, 54100, 54120, 57529, 87898, 87899, 87900–87906.

Hederella vagans section

HEDERELLA VAGANS, new species

PLATE 4, FIGURES 1, 2

Hederella canadensis HALL and SIMPSON (part), Pal. New York, vol. 6, pl. 65, fig. 14, 1887 (not Nicholson, 1874).

Zoarium usually incrusting the epithecated sides of *Favosites* but also growing upon *Heliophyllum* and other cup corals and consisting

of a set of loosely arranged, straggly tubes about 0.4 mm. in width, branching at long intervals, 15 mm. or more, and giving rise to short zooecia 1 mm. in length at angles of 30° to 45°, at distances averaging 2.5 mm. Tubes faintly annulated; zooecial apertures terminal, transversely oval, opening upward and equaling the tubes in diameter. Two zooecia in 5 mm.

Occurrence.—Middle Devonian: Thedford (cotypes), Arkona, and Bartletts Mills, Ontario (Widder shale); Pavilion and 1½ miles south of East Bethany, N. Y. (Tichenor limestone); 2½ miles southwest of Sylvania, Ohio (Silica shale); Ann Arbor, Mich. (drift).

Cotypes.—U.S.N.M. Nos. 26574, 54117, 87969.

HEDERELLA GERMANA, new species

PLATE 4, FIGURE 6

Although related to *H. vagans*, this species can be distinguished by its wider, more coarsely annulated tubes, branching at considerable, although shorter, intervals (12 mm.), usually at a right angle, and its longer, more distantly spaced zooecia emerging at such a low angle as often to remain in contact. Length of zooecial tubes 1.6 mm., width 0.5 mm., with 1 to 2 zooecia in 5 mm.

H. canadensis and *H. crassilinea* are also related species, which have been distinguished under their respective descriptions.

Occurrence.—Hamilton (Widder shale): Thedford, Ontario.

Holotype.—U.S.N.M. No. 87934.

HEDERELLA CONTORTILIS, new species

PLATE 8, FIGURES 5–8

Nicholsonia canadensis DAVIS (not *Hederella canadensis* Nicholson), Kentucky Foss. Corals, pt. 2, pl. 73, figs. 10, 11, pl. 78, fig. 16, 1885 (not pl. 57, fig. 6= *Hernodia davisi;* not pl. 80, fig. 15, undetermined).

Hederella canadensis HALL and SIMPSON (part), Pal. New York, vol. 6, pl. 65, fig. 16, 1887.

Associated with *H. adnata*, and like it incrusting fenestellid Bryozoa, is another species that differs in its distinctly narrower and shorter zooecial tubes (0.4 mm. wide and 1.5 mm. long). It often grows in such profusion as to form a contorted mat, but a colony unobscured by other zoaria or its own branches shows that the zoarial growth is rather regular, consisting of a main axis of a single tube from which branches emerge at an angle of 50° or more at intervals of 3 mm., these emitting zooecial tubes on alternate sides at an angle of 50°–60° and at distances of about their own length with about 3 in 5 mm. Frequently the zooecial tubes all arise on one side of the branch, thus adding confusion among them.

H. vagans has about the same width of tubes, but its zooecia are shorter and branch at less frequent intervals.

Occurrence.—Onondaga (Upper Jeffersonville limestone-*Spirifer acuminatus* bed): Falls of the Ohio.

Cotypes—U.S.N.M. No. 87954.

HEDERELLA ANGULATA (Davis, 1885)

PLATE 7, FIGURES 5, 6

Nicholsonia angulata DAVIS, Kentucky Foss. Corals, pl. 80, fig. 15, 1885.

A species much like *H. vagans* but differing in that the primary axial tubes, 0.3 mm. in width, give rise at short intervals (1.5 mm. to 3 mm.) to long secondary branches at more or less of a right angle, from which in turn emerge very short zooecia (0.5 mm.) at intervals of 2 to 3 mm. at a 45° angle with 1 to 2 in 5 mm. Surface very delicately annulated. Comparisons with *H. rectifurcata* are given under description of the latter.

Occurrence.—Onondaga (Upper Jeffersonville limestone-*Spirifer acuminatus* zone): Falls of the Ohio.

Plesiotype.—U.S.N.M. No. 54092.

HEDERELLA TENERA, new species

PLATE 7, FIGURES 7–9

Associated with *H. angulata* is a more delicate species also closely related to *H. vagans* but distinguished from both by its narrow branches (0.25 mm. in width), which subdivide at an angle less than 45° at intervals of 1.5 to 2 mm., with longer zooecia (1.3 mm. and 3 in 5 mm.) emerging at an equally small angle at long distances. In this, as in the related species, the surface ornament is exceedingly delicate and the transversely oval zooecial apertures bend slightly upward.

Occurrence.—Onondaga (Upper Jeffersonville limestone-*Spirifer acuminatus* bed): Falls of the Ohio.

Cotypes—U.S.N.M. No. 87913.

HEDERELLA ULRICHI, new species

PLATE 13, FIGURE 8

This species is based upon a mold in sandstone, gutta-percha squeezes of which indicate a form related to *H. crassilinea* from the Snyder Creek shale of Missouri but differing in that the zooecia are larger (2 mm. long and 0.7 mm. wide, with 2½ in 5 mm.) and bud alternately from the main axis at smaller angles (less than 45°) so that they form narrow branches, which in themselves bifurcate at distances of about 10 mm. Better specimens will show other characters for this robust species.

The specific name is in honor of Dr. E. O. Ulrich, who collected the type specimen.

Occurrence.—Helderbergian (50 feet below top): Big Stone Gap, Va.
Holotype.—U.S.N.M. No. 93956.

HEDERELLA OCCIDENTALIS, new species

PLATE 6, FIGURE 15

This species, represented by a none-too-well preserved specimen, is described mainly to show the occurrence of *Hederella* in the Devonian faunas of the Western United States. The type, which incrusts a *Schizophoria*, consists of a portion of a frequently branching zoarium, dividing at intervals of 3 mm. at angles of 50° to 60°, emitting zooecia 1.5 mm. long and 0.5 mm. wide, also at a high angle.

Occurrence.—Devonian (Percha shale): Lake Valley, N. Mex.
Holotype.—U.S.N.M. No. 87936.

HEDERELLA CRASSILINEA, new species

PLATE 4, FIGURE 4; PLATE 13, FIGURES 4, 5

Although similar to *H. germana* from the Widder beds of Ontario in the width of zooecia, surface ornamentation, and the right-angled method of branching, this new species can be readily recognized by the more regular and frequent budding of the tubes. These are short (1.3 mm. long and 0.6 mm. wide) and emerge at an angle of about 45° at quite regular intervals of about 2 mm., with 2½ to 3 in 5 mm. Branching occurs at intervals of 5 to 10 mm.

H. camdenensis from the Helderbergian of west Tennessee is also similar but has longer zooecia and less regular budding.

Occurrence.—Devonian: Fulton, etc., Callaway County, Mo. (holotype) (Snyder Creek shale); railroad fill northeast of Randalia (paratype) and Iowa City (paratype), Iowa (Cedar Valley formation).
Holotype and *paratypes.*—U.S.N.M. Nos. 25462; 78639, 94571.

HEDERELLA CAMDENENSIS, new species

PLATE 6, FIGURE 16

This species, represented by a fragmentary zoarium incrusting a *Gypidula*, is described in order to call attention to the presence of this group of the genus in the Helderbergian of Tennessee. Although evidently related to *H. vagans*, the present species branches more frequently, the zooecia are longer (1.6 mm.) and wider (0.5 mm.) and bud from the main axis at an angle of about 45° at more frequent intervals, with 3 zooecia in 5 mm. More complete specimens will probably reveal additional characters.

Occurrence.—Helderbergian (New Scotland-Birdsong shale): Just south of Camden, Tenn.
Holotype.—U.S.N.M. No. 87968.

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HEDERELLA RECTIFURCATA, new species

PLATE 7, FIGURE 16

This species is characterized by its rather straight primary branches from which secondary branches arise at intervals of about 3 mm. almost at right angles, both of which in turn give origin at the same angle (at intervals of 1.5 mm.) to very short zooecia terminated by elliptical apertures directed upward. Branches and tubes about 0.3 mm. in diameter; 2 to 3 zooecia in 5 mm.

The rectangular method of branching and the very short zooecial tubes arising at a right angle make this species of the *H. canadensis* group easily recognized. Although similar to *H. angulata* (Davis) in general dimensions and short buds, *H. rectifurcata* is readily distinguished by its closer branching and its budding at a right angle.

Occurrence.—Middle Devonian: 18-Mile Creek (holotype) and Athol Springs (Wanakah shale), 1½ miles southeast of East Bethany (Moscow-Kashong shale), Kashong Creek (Ludlowville shale), 3 miles west of East Bethany (Centerfield shale) and 1½ miles south of East Bethany (Tichenor limestone), all in New York; 2½ miles southwest of Sylvania, Ohio (Silica shale); Milwaukee, Wis. (Milwaukee limestone); Petoskey Cement Co., Petoskey, Mich. (Traverse-Gravel Point limestone); Thedford and vicinity, Ontario (Widder shale).

Holotype.—U.S.N.M. Nos. 50247, 87923–87926.

Hederella blainvillei section

HEDERELLA BLAINVILLEI Clarke, 1907

PLATE 13, FIGURE 6

Hederella blainvillei Clarke, New York State Mus. Bull. 107, p. 289, fig., 1907; New York State Mus. Mem. 9, pt. 1, p. 242, pl. 48, fig. 2, 1908.

This species, which forms gracefully expanding incrustations upon brachiopod shells, is closely related to *H. ramea* Clarke but differs in its "much more rapidly branching zoaria and consequently shorter cells producing a fuller and denser stock." The original illustration on plate 13 exhibits these features and shows that the bushy aspect of the zoarium is caused by the very regular branching at intervals of about 4 mm. and at an angle of about 30°, and the equally regular budding of the zooecia at the same angle. Width of branches and zooecia 0.5 mm., length of zooecia 2 to 3 mm.

As noted, *H. ramea* Clarke has a similar method of growth but the zooecia are longer and narrower. *Hederella* species,[4] described by Clarke from the Lower Devonian Moose River sandstone of Moosehead Lake, Maine, is almost certainly the same as *H. blainvillei.*

[4] Clarke, New York State Mus. Mem. 9, pt. 2, pl. 21, figs. 18, 19, 1909.

Occurrence.—Devonian (Gaspé sandstone): Portage Road, Gaspé, and Haldemand, Quebec.

Pleisotypes.—U.S.N.M. Nos. 87981, 87982.

HEDERELLA RAMEA Clarke, 1900

PLATE 13, FIGURE 10

Hederella ramea CLARKE, Mem. New York State Mus., vol. 3, No. 3, p. 62, pl. 9, fig. 9, 1900.

As shown by the original illustration and a further enlargement of the holotype on Clarke's plate 9, this species is related to *H. blainvillei*, differing in that branching occurs more regularly and at shorter intervals, sometimes as close together as 3 mm. The zooecial tubes also are not so wide (0.35 mm. instead of 0.5 mm.) and much longer (3 mm.), sometimes reaching a length of an entire branch before giving rise to other zooecia. The angle both of branching and of budding is less than 30°, but both zooecia and branches remain quite separate and form a palmate expansion.

Occurrence.—Oriskany sandstone: Becraft Mountain, near Hudson, N. Y.

Plastoholotype.—U.S.N.M. No. 87922.

HEDERELLA PAVILIONENSIS, new species

PLATE 4, FIGURE 5

Zoarium as in *H. vagans* and *H. ramea*, with the same loose manner of growth but the unilinear axis branches more frequently at a 45° angle, forming a much divided ensemble with quite elongated individual tubes, which bud at an angle less than 45°. Growth in general more robust than in *H. vagans*, the tube diameter being 0.5 mm. and the zooecia 2 to 4 mm. or more long. *H. germana* has the same width of zooecia but differs in its right-angled branching and shorter zooecia.

Occurrence.—Hamilton group: Pavilion and 1½ miles south of East Bethany (Tichenor limestone), and 3 miles west of East Bethany (Centerfield shale), N. Y.

Holotype.—U.S.N.M. Nos. 87932, 87933.

Hederella thedfordensis section

HEDERELLA THEDFORDENSIS, new species

PLATE 1, FIGURES 7–12; PLATE 13, FIGURE 2

Hederella canadensis HALL and SIMPSON (part), Pal. New York, vol. 6, pl. 65, fig. 2, 1887.

Associated with *H. filiformis* in the type locality in equal abundance and also growing usually upon *Spirifer mucronatus thedfordensis*

is a more robust species that differs in that all of its dimensions are greater: The zooecial diameter (0.7 mm.) is twice that of the former; the length of the zooecia is 2.5 mm, they bud at an angle less than 30°, and their number in 5 mm. is 2; the main axis from which the branches emerge at an angle of 60° is strongly and more uniformly developed; and the branching is less uniform. The basal part of an old zoarium consists of an almost solid mass of radiating tubes in which all trace of the method of branching is lost. An interesting feature of the branching is that at intervals of about 4 mm., groups of 4 or 5 short, wide tubes are developed on alternate sides.

H. thedfordensis is similar to *H. nicholsoni*, but in the latter a single zooecium emerges alternately from each side of the branch.

Occurrence.—Middle Devonian: Thedford (cotype), Arkona, etc., Ontario (Arkona and Widder shales); Livingston County, Kashong Creek (Ludlowville); 3 miles west of East Bethany (Centerfield shale), Averys Creek and Hamburg (Wanakah shale), and 1½ miles southeast of East Bethany (cotype) (Kashong shale), all in New York; 2½ miles southwest of Sylvania, Ohio (Silica shale) (cotype); abandoned shale pit, Alpena Portland Cement Co. quarry (Genshaw formation) and Thunder Bay quarry (Alpena-Dock Street clay), all in Traverse group of Alpena County, Mich.

Cotypes.—U.S.N.M. Nos. 26572, 54101, 87927–87931, 87983, 87984.

HEDERELLA NICHOLSONI, new species

PLATE 4, FIGURES 8, 8′; PLATE 12, FIGURE 4

Though resembling *H. helderbergia* in its general proportions, *H. nicholsoni* may be recognized by its broad tubes 2 mm. long and 0.6 mm. thick issuing from the main axis at an angle of about 35° and usually remaining free throughout the entire length. Branching is rather regular, occurring at intervals of 5 to 6 mm. at angles less than 45°; 2½ to 3 zooecia may be found in 5 mm. *H. thedfordensis* is similar but has somewhat larger zooecia and particularly more closely arranged tubes, which in budding give rise to clusters of 4 or 5 on alternate sides.

This specific name is in honor of Dr. H. A. Nicholson, eminent pioneer student of American Paleozoic corals and Bryozoa.

Occurrence.—Middle Devonian: 18-Mile Creek (holotype), Wanakah, Athol Springs, Elma, and Bay View (Wanakah shale), 3 miles west of East Bethany (Centerfield shale), all in New York; Rockport Quarry, Alpena County, Mich. (Traverse-Upper Bell shale) (paratype).

Holotype and paratype.—U.S.N.M. Nos. 72800, 73060, 78159, 87937–87939.

HEDERELLA NODIFERA, new species

PLATE 12, FIGURE 3

A species with the same general features as *H. nicholsoni* and *H. thedfordensis* but with more frequently divided and crowded branches and particularly with a nodelike swelling near the extremity of each zooecium. Division at very acute angles for both branches and zooecia bringing them almost in contact; individual zooecia 3 mm. long and 0.6 mm. wide normally, but 1 mm. across at a node. The node or swollen part of the tube occurs regularly about one-quarter of a tube length behind the aperture. Its cause is unknown, as the type, the only known specimen, gives no clue.

Occurrence.—Helderbergian (Birdsong shale): Perryville, Tenn.

Holotype.—U.S.N.M. No. 87968.

HEDERELLA QUEBECENSIS, new species

PLATE 13, FIGURE 9

This species resembles *H. thedfordensis* in its general measurements and method of branching but differs in the conspicuous clusters of zooecia developed on alternate sides at regular intervals of about 4 mm. with few intermediate single tubes. Gutta-percha impressions of the type, which occurs as a mold in a brachiopod shell, show the tubes to average 2 mm. in length and 0.6 mm. in width, with 5 or 6 to a cluster.

Occurrence.—Devonian (Gaspé sandstone): Near Gaspé, Quebec.

Holotype.—U.S.N.M. No. 94568.

HEDERELLA HELDERBERGIA, new species

PLATE 8, FIGURE 3

The type and only specimen so far discovered incrusts a brachiopod shell and consists of several parallel primary branches emitting at intervals of 4 or 5 mm. secondary branches at such an angle as to form a latticework ensemble. From both the main and secondary branches slightly curved zooecial tubes 2 mm. long and 0.35 mm. wide arise at angles of approximately 45° and about 1 mm. distant from each other, with about 3 zooecia in 5 mm. The secondary branches usually end in a tuft of 4 or 5 zooecia, which, with the latticelike arrangement of the primary and secondary branches, give a characteristic aspect of regularity to the species.

Occurrence.—Helderbergian (New Scotland limestone): Schoharie County, N. Y.

Holotype.—U.S.N.M. No. 26032.

HEDERELLA CHESTERENSIS, new species

PLATE 6, FIGURES 9–11

Zoarium incrusting brachiopods, cup corals, crinoid stems, and other organic objects indiscriminately, where it forms colonies sometimes several square centimeters in area, particularly well distinguished by the curved clusters of zooecia produced in the course of branching. From the single-tubed primary branch a gently curved zooecium emerges at about 45° and within a short distance by successive budding forms a cluster of 4 or 5 zooecia usually curving away from the branch, then after a short interval a similar group arises on the other side. Likewise, the secondary branches emit alternately such zooecial groups. Zooecia are about 2½ mm. long, 0.3 mm. wide, and average 3 in 5 mm.

Occurrence.—Chester group: Marion (cotype), Sloans Valley (cotype), near Stephensport, Smithland, etc., Ky. (Glen Dean limestone); Evansville, Ind. (cotype); and Chester, Ill.

Cotypes.—U.S.N.M. Nos. 50316, 54112, 54095–54099, 54127, 87953.

HEDERELLA ADNATA (Davis, 1885)

PLATE 11, FIGURES 10–12

Nicholsonia adnata DAVIS, Kentucky Foss. Corals, pt. 2, pl. 78, fig. 19, 1885 (not described).

This species, although resembling *H. vagans* in its general zooecial arrangement, differs in that the tubes are wider (0.6 mm.) and more robust in general, the zoarial branching, although irregular, occurs usually at a distance of 5 mm., and the zooecial tubes are much longer (2.5 mm.) and more closely set, with 2 in 5 mm. and an angle of budding of 30°. Although rather common, all the specimens of this species have been found incrusting fenestellid bryozoans.

Occurrence.—Onondaga (Upper Jeffersonville limestone-*Spirifer acuminatus* bed): Falls of the Ohio at Louisville, Ky.

Plesiotypes.—U.S.N.M. No. 54085.

HEDERELLA ? LAXA (Whiteaves, 1891)

PLATE 13, FIGURE 1

Stomatopora laxa WHITEAVES, Contr. Can. Pal., vol. 1, p. 210, pl. 28, figs. 8, 8a, 1891.

The generic position of this species is still doubtful, although it is perhaps best placed with *Hederella*. A gutta-percha squeeze of the type seems to indicate that the zooecia bud from the middle of the side of the preceding tube as in that genus. The branches divide at intervals of 3.5 mm. and at an angle of less than 45°, and the zooecia are unusually short and broad (1.2 mm. long and 0.65 mm. wide),

a combination of characters quite different from other species of *Hederella*.

Occurrence.—Devonian: 40 miles above mouth of Hay River, Canada.

Plastoholotype.—U.S.N.M. No. 54214.

HEDERELLA ALPENENSIS GROUP

This group, typified by an abundant species in the Traverse group of Michigan and represented by 10 species, is characterized by the regular arrangement of the branches, with short, closely spaced zooecia dividing so frequently that a central tube is not developed. Species of *Reptaria* have a somewhat similar aspect, but their zooecia arise so regularly from the basal portion of the opposite one that they form a symmetrical branch of two rows of parallel tubes in contact.

HEDERELLA ALPENENSIS, new species

PLATE 3, FIGURES 1–6

Zoarium incrusting brachiopods, cup corals, massive bryozoans, and other organisms, often spreading over several square centimeters. It consists of a compactly arranged set of short zooecia springing alternately from the side of the opposite preceding one, thus leaving no definite central tube. The zooecia are of equal length (1.1 mm.), arising at such a slight angle as to remain often in contact and almost parallel to each other. Width of zooecia 0.4 mm., with 4 to 5 occurring in 5 mm. Branching occurs frequently at intervals of about 3½ mm. and at an angle of 60°.

Occurrence.—Middle Devonian: Long Lake near Alpena and El Cajon Beach, Alpena County (cotype) (Genshaw formation) abandoned shale pit, Alpena Portland Cement Co., Alpena County, etc. (cotype) (Upper Ferron Point formation), Petoskey Cement Co., Petoskey (cotype), and Bay View (Gravel Point limestone), ½ mile southeast of 4-mile Dam, 7-mile Dam (Norway Point formation) (cotype), and ¼ mile northwest of Bolton, Alpena County (Alpena limestone), all in Traverse group of Michigan; 2½ miles southwest of Sylvania, Ohio (Silica shale); Milwaukee, Wis. (Milwaukee–Lindwurm).

Cotypes.—U.S.N.M. Nos. 54086, 54108, 54111, 54113, 87971–87975.

HEDERELLA AEQUIDISTANS, new species

PLATE 9, FIGURE 6

This well-marked species, occurring as incrustations on cephalopod shells over areas as large as 10 sq.cm., is characterized by its regularly branching habit at right angles from the main axis at a distance of about 3 mm. The main axis is composed of a single row of tubes

from which narrow elongate zooecia emerge at a low angle, then bend almost at right angles, whereupon they themselves issue, alternately to the right and left, rather long zooecial tubes, which remain practically in contact. Length of zooecial tubes about 2 mm., width 0.3 mm., 2 to 3 in 5 mm. measured on the same side of a branch.

Occurrence.—Upper Devonian (Tully limestone-West Brook member): 2½ miles south of Sherburne, N. Y.

Holotype.—U.S.N.M. No. 87970.

HEDERELLA GRACILIOR Clarke, 1900

PLATE 3, FIGURE 12

Hederella gracilior CLARKE, Mem. New York State Mus., vol. 3, No. 3, p. 62, pl. 9, fig. 10, 1900.

This species is evidently closely related to *H. alpenensis*, with which it agrees in general arrangement of the tubes and method of branching (60° angle) but differs in that the zooecia are longer (1.5 mm.) and wider (0.5 mm.) and sometimes exhibit an elongated central tube. Branching occurs at intervals of 6 to 7 mm., with 3 to 3½ zooecia in 5 mm. Only the type specimen is known, and additional material may show further characters.

Occurrence.—Oriskany sandstone: Becraft Mountain, near Hudson, N. Y.

Plastoholotype.—U.S.N.M. No. 87912.

HEDERELLA EDWARDSI, new species

PLATE 4, FIGURE 7

This new species, allied to *H. alpenensis*, differs in its more robust characters. While the method of branching is similar (angle of about 30°), occurring at intervals of 6 mm., the tubes are much larger, being 2.5 mm. long and 0.6 mm. wide, with about 2 zooecia in 5 mm. and budding at an angle of about 20°. The surface ornamentation is more evident, and in general the tubes have a more irregular appearance. The specific name is in honor or Dr. Ira Edwards, curator of geology of the Milwaukee Public Museum.

Occurrence.—Middle Devonian (Milwaukee limestone-Lindwurm member): Milwaukee, Wis.

Holotype.—U.S.N.M. No. 57531.

HEDERELLA HALYSON (Fenton and Fenton, 1924)

PLATE 2, FIGURE 6; PLATE 5, FIGURES 4, 5; PLATE 12, FIGURE 1

Hernodia halyson FENTON and FENTON, Strat. and Fauna Hackberry Stage, Upper Devonian, p. 73, pl. 17, fig. 4, pl. 18, fig. 4, 1924.

Although originally referred to *Hernodia* in which the zooecia arise rather regularly from the middle portion of the preceding tube, this

character is shown only in the younger branches. Older parts of the zoarium, as shown on plate 5, figure 4, bud as in *Hederella*. The zoarium forms small colonies upon brachiopods and cup corals, consisting of a central, rather confused part in which, however, the shape of the zooecia and radial arrangement of the branches around the ancestrula are visible, the terminal portions of the branches presenting the more regular budding and branching, the latter at an angle of 60°. Here the zooecia arise alternately from about the middle of the preceding one, are about 2 mm. long and 0.55 mm. wide, with 3 in 5 mm. measuring on the same side of the branch. In all parts of the colony the zooecia are rather straight, short, and stout, budding at angles of 25° and remaining free a considerable part of their length.

Occurrence.—Devonian: Rockford and vicinity (Hackberry-Cerro Gordo shale), Buffalo (Cedar Valley formation), Iowa; Milwaukee, Wis. (Milwaukee limestone).

Plesiotypes.—U.S.N.M. Nos. 54083, 66222, 94561.

HEDERELLA PERSIMILIS, new species

PLATE 2, FIGURES 4, 5

Associated with *H. alpenensis* at several Michigan localities is a form closely allied but exhibiting tubes regularly twice as long and considerably wider. This is here separated as a distinct species. Zooecia 2 mm. in length and 0.5 mm. in width but sometimes as much as 3 mm. long. As a rule 3 zooecia occur in 5 mm., but in some parts of the zoarium 1½ occupy the same space. Branching occurs at 6-mm. intervals with a tendency to form clumps of zooecia at the bifurcation.

Occurrence.—Middle Devonian: Bay View and Petoskey Cement Works, Petoskey (cotypes), Charlevoix (Gravel Point limestone), Norway Point Dam (Norway Point formation), Partridge Point, 3 miles south of Alpena (Partridge Point formation), 1.6 miles north of Norwood, Charlevoix County (Petoskey formation), all in the Traverse group of Michigan; Athol Springs, N. Y. (Wanakah shale); Thedford, Ontario (Widder shale).

Cotypes.—U.S.N.M. Nos. 87878–87880, 87974.

HEDERELLA RUGOSA, new species

PLATE 2, FIGURE 7; PLATE 3, FIGURES 7, 8

Complete zoaria of this well-marked species have been found incrusting cup corals and other organisms. Starting with an ancestrula, a small smooth bulb similar to that in typical Cyclostomata, it then passes through a stage of frequently dividing, strongly rugose tubes, which emerge from the main axis at a considerably high angle to the

mature stage where branching occurs less often (at intervals of about 4 mm. and an angle of 40°), and the zooecia remain more in contact with each other (budding at 20°), forming a biserial arrangement. Measurements in the mature stage: Zooecia about 2 mm. in length and 0.6–0.7 mm. in width, with about 3 in 5 mm. Surface of tubes strongly rugose.

Occurrence.—Middle Devonian: Erie County (cotype) (Wanakah shale), Pavilion and 1½ miles south of East Bethany (Tichenor limestone), 3 miles west of East Bethany (Centerfield shale), 1½ miles southeast of East Bethany (Kashong), Moscow (Moscow shale-Windom member), and Canandaigua Lake and York (Ludlowville shale), all in New York; Thedford and Arkona, Ontario (cotype) (Widder shale); Thunder Bay Quarry, Alpena, Mich. (cotype) (Alpena limestone) Partridge Point, 3 miles south of Alpena (Partridge Point formation), 1½ miles northeast of Bay View (Petoskey formation), all in the Traverse group of Michigan.

Cotypes.—U.S.N.M. Nos. 54082, 87916, 87950–87952.

HEDERELLA CONFERTA (Hall, 1881)

PLATE 9, FIGURES 4, 5

Ptilionella conferta HALL, Trans. Albany Inst., vol. 10, p. 195, 1883 (abstract, p. 195, 1881); Rep. State Geol. New York, 1883, p. 56, 1884.

Hederella conferta HALL and SIMPSON, Pal. New York, vol. 6, p. 279, 1887.—HALL, 10th Ann. Rep. State Geol. New York, 1890, p. 56, 1891; 44th Ann. Rep. New York State Mus., p. 86, 1891.

Our description of this interesting species, heretofore unfigured, is based upon a specimen incrusting an *Orthoceras* over a space of more than 32 sq. cm. The general zoarial arrangement and branching of the tubes are similar to that in *H. aequidistans*, but the strong zooecial annulations in *H. conferta* and the greater number of tubes to a branch will serve to distinguish them. Branching occurs at intervals of about 4 mm. and an angle of 45°, with zooecia 2 mm. in length and 0.35 mm. in width and budding at 45°.

Occurrence.—Hamilton (Ludlowville shale): Canandaigua Lake, Kashong Creek, etc., N. Y.

Plesiotype.—U.S.N.M. No. 54121.

HEDERELLA CLARKEI, new species

PLATE 10, FIGURE 3

The type and only known specimen incrusts a *Fistulipora* and is readily distinguished by the many rows of short tubes to a branch due to their frequent budding at a low angle. Branching occurs at intervals of 3 mm. and an angle of more than 45°, with the zooecial tubes

averaging 1.5 mm. in length, 0.35 mm. in width, and about 4 in 5 mm. Rapid proliferation on alternate sides of the single initial tube of a branch and its successors quickly increase the number of rows so that as many as 10 may occur at a bifurcation.

Although related to *H. conferta* in growth features, the shorter and less strongly marked zooecia of *H. clarkei* arranged in many rows will easily distinguish it. The specific name is in memory of the late Dr. John M. Clarke, eminent student of Devonian paleontology.

Occurrence.—Hamilton (Centerfield shale): 3 miles west of East Bethany, N. Y.

Holotype.—U.S.N.M. No. 87987.

HEDERELLA CALVINI, new species

PLATE 9, FIGURE 2

Zoarium attached to a flat frond of *Fistulipora* and consisting of rather broad branches dividing rather regularly at intervals of about 5 mm. at an angle of less than 30°, composed of flattened zooecial tubes about 2 mm. in length and 0.4 mm. in width budding from the main axis at such a low angle as to remain in contact throughout their length and so frequently as to show 4 or more rows in a single branch. The apertures are narrow, transversely elliptical; 2½ zooecia occur in 5 mm.; surface ornamentation of very delicate transverse lines. Branches in the older part of the zoarium so close together as to form solid incrustations. The broad branches dividing at small angles and the four or more rows of zooecia in close contact in most of the branches readily distinguish this fine species, named in honor of the late Dr. Samuel Calvin, leading student of Iowa geology and paleontology.

Occurrence.—Devonian (Cedar Valley formation): Davenport, Iowa.

Holotype.—U.S.N.M. No. 54091.

HEDERELLA MAGNA GROUP

The robust zoarium of *Hederella magna*, consisting of a thick, rather infrequently branching tubular axis from which large ventricose but usually short zooecia emerge at close intervals alternately to right and left, has a type of growth shared by the nine forms here classified under this heading.

HEDERELLA MAGNA Hall, 1881

PLATE 3, FIGURES 9, 10

Hederella magna HALL, Trans. Albany Inst., vol. 10, p. 195, 1883 (abstract, p. 195, 1881); Rep. State Geol. New York, 1883, p. 55, 1884.—HALL and SIMPSON, Pal. New York, vol. 6, p. 280, pl. 65, fig. 15, 1887.—WHITEAVES, Contr. Can. Pal., Geol. Surv. Canada, vol. 1, pt. 5, p. 382, 1898.—BASSLER, *in* Cleland, Wisconsin Geol. Nat. Hist. Surv., Bull. 21, sci. ser. 6, p. 55, pl. 6, fig. 6, 1911.—STEWART, Geol. Surv. Ohio, ser. 4, Bull. 32, p. 26, pl. 1, fig. 19, 1927.

Zoarium incrusting cup corals and other organisms over considerable areas and consisting of large, swollen zooecia 2.2 mm. long and 1 mm. wide at the aperture, emerging alternately from a long central tube, which may be as much as 15 mm. in length before bending outward as a typical zooecium and giving rise to another similar tube from which the zooecia bud. Branching rather infrequent, with sometimes an interval of 20 mm. Zooecia short for their size, rapidly expanding, with 2 to 2.5 in 5 mm. measuring on one side of a branch, and usually adherent throughout the length (angle of less than 20°). Surface with delicate annulations throughout and coarser wrinkles taking the place of every third or fourth annulation. Apertures fairly round and bent slightly upward.

The robust zoarium with short, wide zooecia in contact and regular arrangement and the infrequent branching characterize this fine species.

Occurrence.—Middle Devonian: Bay View, etc., Erie County, York (plesiotype) (Wanakah shale), Pavilion (Tichenor limestone), 3 miles west of East Bethany and Murder Creek, Darien (Centerfield shale), and 18-Mile Creek (Moscow shale), all in New York; Arkona (Arkona shale) and Thedford (Widder shale), Ontario; 2½ miles southwest of Sylvania, Ohio (Silica shale).

Plesiotype.—U.S.N.M. Nos. 54107, 87912, 87962–87966.

HEDERELLA MAGNA PRAECEDENS, new variety

PLATE 3, FIGURE 11

Hederella magna CLARKE, Mem. New York State Mus., vol. 3, No. 3, p. 61, pl. 9, fig. 10, 1900.

Zooecia shorter (2.0 mm. in length and 1.0 mm. wide) and blunter than in typical *H. magna*, with about 3 instead of 2.5 in 5 mm.

The single specimen upon which this variety is founded shows that it differs from the typical Hamilton form in its longer, blunter, more parallel-edged tubes arising at such a narrow angle as to remain in close contact. Branching appears to occur at shorter intervals and other specimens may show further differences.

Occurrence.—Oriskany sandstone: Becraft Mountain near Hudson, N. Y.

Plastoholotype.—U.S.N.M. No. 94163.

HEDERELLA MAGNIVENTRA, new species

PLATE 10, FIGURES 5, 6

This vigorous species may be easily recognized by its broad, stout, linear branches with a single row of tubes dividing at irregular and sometimes long intervals, usually at a right angle, with the zooecia

emerging from one side, quite swollen at the base, and with round, erect apertures. The branches are 1.2 mm. in diameter, the zooecial tubes are 2 mm. or less in length, the aperture averages 0.75 mm. in width, and 2½ to 3 zooecia occur in 5 mm. Surface very minutely porous and with annulations so faintly indicated that it is almost smooth.

Occurrence.—Middle Devonian (Traverse): Petoskey Cement Co., Petoskey (holotype) (Lower Gravel Point limestone), Thunder Bay River (Norway Point formation), Alpena and Thunder Bay quarry (Alpena limestone, Dock Street clay), all in Michigan.

Holotype.—U.S.N.M. Nos. 54110, 87940, 87942–87945.

HEDERELLA OBESA, new species

PLATE 10, FIGURE 4

Although evidently related to *H. magniventra*, this species may be recognized by its more regular zoarium branching at an angle of 45° or less and at intervals of 10 to 12 mm., by its short, swollen zooecial tubes arranged alternately on both sides of the central axis instead of one, and by the larger dimensions of the zooecia, their length averaging 2.7 mm., their width 1 mm., and 2 to 2.5 occurring in 5 mm. on the same side of a branch. The type specimen is a colony covering about 35 sq. cm. of a flat frond of *Fistulipora*.

H. major has a similar method of growth but has tubes half again as long, which expand gradually in diameter instead of immediately becoming ventricose.

Occurrence.—Hamilton (Ludlowville-Tichenor limestone): 18-Mile Creek, N. Y.

Holotype.—U.S.N.M. No. 87935.

HEDERELLA MAJOR, new species

PLATE 8, FIGURE 4

The type specimen incrusting a lamellate *Fistulipora* represents a new species in which the tubes are unusually large and in close contact for the greater part of their length, arising alternately from the side of the preceding one and forming branches 4 mm. wide, arising at an angle of 45°. The zooecial tubes average 4 mm. in length and 1.5 mm. in width, with 2 in 5 mm.

The unusual size of the zooecial tubes and branches of this species makes its recognition easy. The surface ornamentation is as in other members of the family, and the method of budding is exactly the same as in *Hederella*, so that it does not seem possible that it could belong to the Auloporidae, where it might be referred.

Occurrence.—Hamilton (Widder shale): Thedford, Ontario.

Holotype.—U.S.N.M. No. 26576.

HEDERELLA MICHIGANENSIS, new species

PLATE 10, FIGURES 1, 1′, PLATE 12, FIGURE 5

The several zoaria upon which this species is based are clearly related to the other members of the *H. magna* group, but they differ in that the branching is less regular, the zooecia are longer and emerge usually at a greater angle, and the microscopic dimensions although large for the genus are all smaller. In *H. michiganensis* the zooecial tubes average 2 mm. in length, their diameter is about 0.8 mm., and they issue from the main axis at intervals of their own length so that usually 2 occur in a distance of 5 mm. The details of the surface are rather similar to the other members of the group.

Occurrence.—Middle Devonian: Lake Shore at Bay View, Emmet County (cotypes) (Upper Gravel Point limestone), Thunder Bay River (Norway Point formation), Rockport quarry, Alpena County (cotype) (Upper Ferron Point formation), 1.6 miles north of Norwood, Charlevoix County (Petoskey formation), ¼ mile northwest of Bolton, Alpena County (Alpena limestone), all in Traverse group of Michigan; Falls of the Ohio (Sellersburg limestone).

Cotypes.—U.S.N.M. Nos. 87941, 93966, 94591.

HEDERELLA ROBUSTA, new species

PLATE 10, FIGURE 2; PLATE 12, FIGURES 6, 7

The robust colony in this species is occasioned by the very frequent branching of zooecial tubes, which in their general form and size are similar to those in other species of the group. Branching occurs at rather regular intervals of about 6 mm. and an angle of 45°, and the initial zooecium of a branch gives rise by frequent budding to 5 or 6 tubes before a new branch commences. The zooecia after leaving the parent tube vary in length according to age, but the average mature one is at least 3 mm. long and 1.2 mm. wide, with 2 usually occurring in 5 mm. Budding is usually at an angle of 30°. Surface very finely annulated with slightly coarser ridges at intervals. Although similar to *H. hibbardi*, the growth is more robust, tubes are larger, and branching more distinct.

Occurrence.—Middle Devonian: Norway Point Dam (holotype) (Norway Point formation) and other localities in Alpena County (Genshaw and Ferron Point formations), 1½ miles northeast of Bay View and 1.6 miles north of Norwood, Charlevoix County (Petoskey formation), ¼ mile northwest of Bolton, Alpena County (Alpena limestone), all in Traverse group of Michigan; 1½ miles southeast of East Bethany (Kashong shale) (paratype) and 3 miles west of East Bethany, N. Y. (paratype) (Centerfield shale); Thedford, Ontario (Widder shale).

Holotype and paratypes.—U.S.N.M. Nos. 87946, 93961, 93964, 93965, 93968.

HEDERELLA REIMANNI, new species

PLATE 12, FIGURE 8

Although of large proportions, this giant species is so similar to such minute but typical forms as *H. concinna* that there can be no doubt of its correct reference to *Hederella*. In *H. reimanni* the zooecial tubes are about 4 mm. long and 1.0 mm. wide, with about 1 in 5 mm., budding at such an acute angle as to nearly remain in contact, with zoarial branching at 10-mm. intervals, thus making this the largest *Hederella* known.

The specific name is given in recognition of the researches of Irving G. Reimann, of the Buffalo Society of Natural History, on the geology of western New York.

Occurrence.—Middle Devonian: Bay View (holotype) and 18-Mile Creek (Wanakah shale), and Pavilion (Tichenor limestone), N. Y.; 2½ miles southwest of Sylvania, Ohio (Silica shale).

Holotype.—U.S.N.M. Nos. 93963, 93967.

HEDERELLA HIBBARDI, new species

PLATE 4, FIGURES 3, 3′

The zoarium in this species occurs as a thick mat of large, broad zooecial tubes in close contact, which when analyzed shows the characteristic branching of this section, differing from such species as *H. robusta* in that the zooecia are less in length (2.5 mm.) and in width (0.7 mm.). Branching occurs at short intervals, averaging perhaps 4 mm., but at such an acute angle (20°) that the branches are usually in contact; 2½ to 3 zooecia may be measured in 5 mm.

The specific name is in honor of Raymond R. Hibbard, of Buffalo, N. Y., well-known student of the Bryozoa and Middle Devonian faunas.

Occurrence.—Hamilton (Arkona shale): 1 mile east of Marshs Mills and Arkona, Ontario.

Holotype and paratype.—U.S.N.M. No. 87967.

HEDERELLA PARALLELA GROUP

In the eight species classified under this heading the zooecia bud at such a low angle from the main axis that they usually remain in contact throughout the greater part of their length, thus giving the aspect of parallel arrangement.

HEDERELLA PARALLELA, new species

PLATE 2, FIGURES 1–2′

Hederella canadensis HALL and SIMPSON, Pal. New York, vol. 6, pl. 65, fig. 3, 1887.—GRABAU and SHIMER, North Amer. Index Foss., p. 120, fig. 179b, 1907.

Zoaria incrusting cup corals and other organisms where they form colonies as much as 7 cm. in length and branching at intervals of 8 mm. at angles of about 45°. Each branch appears to be made of three parallel rows of elongate tubes, which in reality consist of a central one giving rise on alternate sides to zooecia about 2 mm. long and 0.35 mm. wide at such a low angle as to remain in contact. Surface of tubes transversely rugose; apertures transversely oval and equaling the tubes in width; 2½ to 3 zooecia in 5 mm. measured along the same side of a straight branch.

Occurrence.—Hamilton group: Moscow (cotype) (Moscow shale–Windom member), 3 miles west of East Bethany (Centerfield shale), and 1½ miles south of East Bethany (cotype) (Tichenor limestone), 1½ miles southeast of East Bethany (Kashong shale), all in New York; Thedford, Ontario (Widder shale) (cotype).

Cotypes.—U.S.N.M. Nos. 87947–87949.

HEDERELLA COMPACTA, new species

PLATE 5, FIGURE 13

Allied to *H. parallela* is a species from the Middle Devonian of Michigan, with a similar growth habit but differing in that the zooecia are conspicuously shorter and broader (1.5 mm. long by 0.7 mm. wide), with 4 to 4½ in 5 mm., and budding at an equally acute angle. The initial tube from which they arise is so narrow that the zooecia appear as a parallel, compactly and alternately arranged series of rectangular tubes on each side of the middle line. Branching of the zoarium occurs at an angle of 20° and more frequently than in other members of the group.

Occurrence.—Middle Devonian (Traverse-Partridge Point formation): Partridge Point, 3 miles south of Alpena, Mich.

Holotype.—U.S.N.M. No. 54114.

HEDERELLA BILINEATA, new species

PLATE 5, FIGURES 9–11

The specific name of this minute species of the *H. parallela* group is suggested by the characteristic bilineate arrangement of the two rows of small, short, broad rectangular zooecia. The zoarium branches rather regularly at intervals of 3 mm. in the vicinity of the ancestrula, but elsewhere it may form delicate lines of zooecia 9 mm. or more in length before division occurs, in this case at an angle of 60°–90°. The zooecia average 1.0 mm. in length and about 0.3 mm. in width, with 5 to 6 in 5 mm.; they bud from the main axis at such a low angle that they remain confluent with each other, and are decorated with delicate transverse wrinkles. Apertures transversely oval, rising at an angle from the zooecial tubes.

Occurrence.—Middle Devonian: 3 miles west of East Bethany (cotype) (Centerfield shale), York (Ludlowville shale) (cotype), 18-Mile Creek (Wanakah shale), 1½ miles south of East Bethany, and Pavilion (Tichenor limestone), all in New York; Arkona, Ontario (Widder shale); 2½ miles southwest of Sylvania, Ohio (Silica shale); Lebanon, Ky.

Cotypes.—U.S.N.M. Nos. 87976–87980.

HEDERELLA CONSIMILIS, new species

PLATE 5, FIGURE 12

Although closely allied to *H. bilineata* in size and general aspect, this new species differs in that it branches quite regularly at intervals of about 4½ mm. at a right angle, that the zooecia, although of about the same length (1 mm. long and 0.2 mm. wide, and 6 in 5 mm.), are narrower and bud at a wider angle (25°), so that they do not remain in contact throughout their length.

Occurrence.—Onondaga (Upper Jeffersonville limestone–*Spirifer acuminatus* bed): Falls of the Ohio.

Holotype.—U.S.N.M. No. 54123.

HEDERELLA LOUISVILLENSIS, new species

PLATE 5, FIGURE 8

Although similar to *H. consimilis* in general aspect, the larger, wider, more swollen, and more rapidly expanding zooecia of this new species will distinguish it at once. The zooecia average 1.5 mm. in length, 0.4 mm. in width, and 4 occur in 5 mm. Budding occurs at an angle of 25° and branching at intervals of about 10 mm. and an angle of 50°.

Occurrence.—Onondaga (Upper Jeffersonville limestone–*Spirifer acuminatus* bed): Falls of the Ohio, Louisville, Ky.

Holotype.—U.S.N.M. No. 87985.

HEDERELLA ROMINGERI, new species

PLATE 9, FIGURE 3

In this new species, named in honor of Dr. Carl Rominger, pioneer student of American Paleozoic corals, the zoarium occurs as a dense mat of tubes incrusting some foreign object, in the case of the holotype a ramose bryozoan. By unraveling the tubes it may be perceived that branching occurs at intervals of 5 mm. and that both the branches and the zooecia divide at such a small angle that the resulting colony is closely compacted. The zooecial tubes average 2.2 mm. in length, 0.5 mm. in width, and about 3 zooecia occur in 5 mm.; surface strongly rugose.

The presence of a narrow central tube, from which the zooecia bud alternately to right and left, and the parallel arrangement of the latter

because they remain in contact seem to relate this species to the *H. parallela* group.

Occurrence.—Middle Devonian (Traverse–Genshaw formation): Long Lake near Alpena, Mich.

Holotype.—U.S.N.M. No. 54106.

HEDERELLA TRISERIATA, new species

PLATE 2, FIGURE 3

This species is similar to *H. parallela* in the development of a long median tube that extends for some distance before it terminates as a zooecium, so that the branch appears to be made of three parallel rows. Compared further with *H. parallela*, the zooecial tubes are shorter and broader, averaging 1.6 mm. in length, with a width of about 0.4 mm. and an angle of budding of 25°. The branch is about 1.3 mm. wide and divides more frequently and at an angle of 45°; 3 zooecia occur in 5 mm.

Occurrence.—Devonian (Snyder Creek shale): Fulton, Mo.

Holotype.—U.S.N.M. No. 25462.

HEDERELLA VARSOVIENSIS, new species

PLATE 9, FIGURE 1

The fragmentary zoarium forming the holotype of this species incrusts a *Fenestrellina* and seems to belong to the *H. parallela* group because of the narrow branches with parallel zooecial tubes in its early stages, but later it forms compact masses by frequent division. The initial branches are only about 1 mm wide and divide at considerable intervals, often 9 mm; later division occurs at close intervals (3 mm.) and at such a low angle that a fan-shaped expansion of closely set tubes results. The tubes average 2 mm. in length, 0.35 mm. in width, and 2 to 3 occur in 5 mm. Their surface ornamentation is a very delicate but distinct transverse annulation.

Occurrence.—Mississippian (Warsaw limestone): Warsaw, Ill.

Holotype.—U.S.N.M. No. 54098.

HEDEROPSIS, new genus

Zoarium externally similar to *Hederella* but distinguished internally by the presence of a well-defined longitudinal septum within the zooecial tubes along their basal side. In some tubes this septum or carina is joined at right angles by transverse partitions at regular intervals, thus dividing the base of the zooecium into two series of parallel compartments. The purpose of the septum and compartments is unknown, but as they appear in at least six species having other characters in common it is believed they form a good generic character.

Genotype: *Hederopsis typicalis*, new species. Devonian (Onondaga, Hamilton).

HEDEROPSIS TYPICALIS, new species

PLATE 14, FIGURES 2–6

Zoarium incrusting fenestellid Bryozoa and other organic objects, formed of robust cylindrical tubes averaging 3 mm. in length and 1.3 mm. in width, budding at an angle of 45°, with 3 to 4 in 5 mm., and branching at intervals of 5 mm. and 45° angle. The tubes are attached by only a small portion of their basal surface and in budding often grow over each other so as sometimes to form a composite colony of a centimeter or so in thickness. Apertures large, open, terminal, exhibiting on their basal side the characteristic septum and the transverse partitions. Occasionally the zoarium becomes freed of the object upon which growth started, in which case it may be clearly noted how one zooecium serves as a central tube giving rise alternately on each side to the usual zooecia, which in turn bud at intervals to form a central tube of a new branch. Both upper and under sides of the tubes are strongly wrinkled.

Occurrence.—Onondaga (Upper Jeffersonville limestone–*Spirifer acuminatus* bed): Falls of the Ohio.

Cotypes,—U.S.N.M. No. 54093.

HEDEROPSIS RAASCHI, new species

PLATE 14, FIGURE 1

This well-developed species shows considerable resemblance to the *H. magna* group of *Hederella,* but the interior of the tubes exhibits the characteristic basal carina of *Hederopsis.* The zoarium incrusts brachiopod shells, ramose Bryozoa, and other organisms indiscriminately, forming colonies of several square centimeters in size, composed of short, broad branches arising rather regularly at intervals of 5 mm. or less at an angle of about 60°, each starting with a single tube that buds to the right and left alternately several times before a new branch arises. This arrangement is rather marked when the growth is regular. The zooecial tubes average about 2.5 mm. in length and 0.7 mm. in width, budding at an angle of 25°. The apertures are terminal and more rounded than usual. The characteristic basal septum is easily distinguished on the better-preserved tubes. Surface ornamentation of rugose wrinkles with a faintly pitted or porous structure on all the walls.

Although closely related to the genotype, this species may be easily distinguished by its much smaller zooecial tubes and different method of branching and budding. The specific name is in recognition of the work of Gilbert Raasch upon the Milwaukee Devonian section.

Occurrence.—Middle Devonian (Milwaukee limestone, Lindwurm member): Milwaukee, Wis.

Holotype.—U.S.N.M. No. 57530.

HEDEROPSIS BIFURCATA, new species

PLATE 14, FIGURE 9

This species forms regularly bifurcating expansions upon fenestellid Bryozoa, composed of somewhat narrow elongate zooecia 3 to 4 mm. in length and 0.35 mm. in width, with about 2 in 5 mm. Branching occurs rather regularly at intervals of 5 or 6 mm., each branch consisting of a main tube giving rise on alternate sides at distances of 2 mm. to new tubes at a low angle but remaining separate. The median carina, although often not so well preserved in the tubes, is frequently represented by traces in the form of an excavation.

The narrow zooecia and the regularity of bifurcation of both branches and tubes well characterize this species.

Occurrence.—Onondaga (Upper Jeffersonville limestone–*Spirifer acuminatus* bed): Falls of the Ohio.

Holotype.—U.S.N.M. No. 87890.

HEDEROPSIS CONNATA, new species

PLATE 14, FIGURE 10

In this robust species the characteristic basal septum is well developed and the zooecial tubes are unusually large, their measurements being 4 to 5 mm. in length and 1 mm. wide, with 1 to 2 in 5 mm. Branching occurs rather regularly at intervals of about 6 mm. and angle of 45°, each branch consisting of a broad expansion of 4 or 5 rows of tubes and budding at 45°. The zooecia are usually in contact especially along the middle line. Budding occurs at close intervals on alternate sides of the main axis, thus increasing the compact aspect of the zoarium.

The broad, solid, regularly dividing branches of long, wide, closely arranged zooecia well characterize this species.

Occurrence.—Onondaga (Upper Jeffersonville limestone–*Spirifer acuminatus* bed): Falls of the Ohio.

Holotype.—U.S.N.M. No. 87891.

HEDEROPSIS CURTA, new species

PLATE 14, FIGURE 7

This neat species is characterized by its short, broad tubes with erect, rounded apertures arranged in bilinear branches, which bifurcate at an angle of about 30° at intervals of about 6 mm. The first zooecium of a branch is 3 mm. in length, but the following average only 1½ mm., although the width varies little from 0.66 mm. Budding occurs not laterally as in *Hederella* but from the underside at an acute angle, so that each zooecium overlaps the succeeding one. There are 2 to 3 zooecia in 5 mm., measuring along one side of the branch.

The zooecial diameter is similar to that in *H. raaschi*, but the bilinear arrangement and quite different method of branching will serve to distinguish *H. curta*.

Occurrence.—Onondaga (Upper Jeffersonville limestone–*Spirifer acuminatus* bed): Falls of the Ohio.

Holotype.—U.S.N.M. No. 54089.

HEDEROPSIS LONGITUBA, new species

PLATE 14, FIGURE 8

This species is readily recognized by its long zooecial tubes and by the well-marked carina or longitudinal septum on their basal wall. The zooecia bud alternately from the main axis at such a low angle that for a portion of their length they remain in contact and then diverge slightly. The tubes are unusually long, 4 mm. in length and 0.66 mm. in diameter with 1 or 2 in 5 mm. As usual the main axis persists for some distance before ending as a zooecium and giving rise to another tube, which continues as the axis. The zooecia also are rather rounded and tend to become detached from the substratum. In budding they frequently cross the main axis or otherwise depart from normal regularity. However, in normally growing zoaria definite branching occurs at intervals of about 6 mm. The apertures are terminal, broadly elliptical, with the median carina plainly visible within them.

Occurrence.—Onondaga (Upper Jeffersonville limestone–*Spirifer acuminatus* bed): Falls of the Ohio.

Holotype.—U.S.N.M. No. 87889.

Genus REPTARIA Rollé, 1851

Reptaria ROLLÉ, *in* Leonhard and Bronn, Neues Jahrbuch, p. 810, 1851.—HALL and SIMPSON, Pal. New York, vol. 6, p. 25, 1887.—MILLER, North Amer. Geol. Pal., p. 320, 1889.—SIMPSON, 14th Ann. Rep. State Geol. New York, 1894, p. 599, 1897.—GRABAU, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 178, 1899.—NICKLES and BASSLER, U. S. Geol. Surv. Bull. 173, p. 21, 1900.—PRANTL, Acta Musei Nationalis Pragae, vol. 1 (B), p. 80, 1938.

Ptilioneila HALL, Trans. Albany Inst., vol. 10, p. 599, 1883 (abstract, p. 195, 1881).

Bryozoon BARRANDE, Syst. Sil. Centre Boheme, Cephalopoda, vol. 11, pl. 248, 1868.

In this genus the cylindrical annulated zooecia are all alike in shape and length and arise alternately from the basal part of the preceding one at a low angle and with such regularity as to remain in contact almost their whole length, and furthermore the branches divide so uniformly that the zoarium altogether has a featherlike aspect. The regularity of budding gives the impression that the zooecia arise from a central line, but this is not true, since well-preserved examples

as well as weathered specimens show that the regularity is due to the uniform size of the zooecia and direction of budding, and also since each arises near the base of the preceding one on the opposite side of the branch. The surface characters and the shape of the aperture are the same as in *Hederella*.

Reptaria can, therefore, be considered as a *Hederella* in which the zooecia arise so nearly opposite each other as to give the branch the appearance of two equal parallel rows arising from a median line. In addition to the following species, the genus includes *Reptaria* (*Bryozoon*) *steiningeri* (Barrande, 1868) (*Thamnocoelum pennulatum* Počta, 1894) and *R. gigas* Prantl, 1938, from the Silurian and Devonian of Bohemia.

REPTARIA STOLONIFERA Rollé, 1851

PLATE 16, FIGURES 4–8

Reptaria stolonifera ROLLÉ, in Leonhard and Bronn, Neues Jahrbuch, p. 810, pl. 9, figs. 5, 6, 1851.—HALL and SIMPSON, Pal. New York, vol. 6, p. 274, pl. 65, pp. 17–19, 1887.—SIMPSON, 14th Ann. Rept. State Geol. New York, 1894, pl. 25, figs. 8, 9, 1897.—GRABAU, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 178, fig. 76, 1899.—GRABAU and SHIMER, North Amer. Index Foss., p. 120, fig. 180, 1907.—BASSLER, *in* Cleland, Wisconsin Geol. Nat. Hist. Surv. Bull. 21, sci. ser. 6, p. 57, pl. 6, figs. 7, 8, 1911.—STEWART, Geol. Surv. Ohio, ser. 4, Bull. 32, p. 27, pl. 2, figs. 1, 2, 1927.

Ptilionella penniformis HALL, Trans. Albany Inst., vol. 10, p. 195, 1883 (abstract, p. 195, 1881); Rep. State Geol. New York, 1883, p. 56, 1884.

Ptilionella nodata HALL, Trans. Albany Inst. vol. 10, p. 195, 1883 (abstract, p. 195, 1881); Rep. State Geol. New York, 1883, p. 57, 1884.

Reptaria nodata HALL and SIMPSON, Pal. New York, vol. 6, p. 276, 1887.

The zoarium in this species, the genotype, usually incrusts cephalopod shells, where it covers areas as much as 50 sq. cm., composed of branches of a uniform diameter of about 3 mm. dividing at long intervals at angles of 45°–60°, but sometimes as often as every 10 mm. or even less. Zooecia strongly annulated, the rings at times appearing rather nodose, budding from near the base of the opposite preceding one at an angle of less than 45° and increasing in width and curving gently outward, attaining a length of 3 mm. and a width of 0.5 mm. Measuring on one side of a branch, 5 to 6 zooecia in 5 mm.

The type of *Reptaria nodata* Hall proves to be a much-branched example of *R. stolonifera*. *Thamnocoelum pennulatum* Počta, 1894, from the Devonian (E_2) of Bohemia, judged from the illustration here reproduced (pl. 16, fig. 9), is certainly a very closely related species.

Occurrence.—Middle Devonian: Cazenovia, Brookfield, Kashong Creek, etc., N. Y. (Ludlowville shale); Thedford, Ontario (Widder shale); Milwaukee, Wis. (Milwaukee limestone-Lindwurm member); 2½ miles southwest of Sylvania, Ohio (Silica shale); Falls of the Ohio (Sellersburg limestone).

Plesiotypes.—U.S.N.M. Nos. 54577, 87892, 87893.

REPTARIA GASPÉENSIS, new species

PLATE 16, FIGURE 1

The type specimen of this species, which incrusts a brachiopod, shows that the zooecia are as wide as but much shorter and more nodose than in *R. stolonifera*, and the branches subdivide at closer intervals at an angle of 45°. Zooecia 1.5 mm. long, 0.5 mm. wide, with 6 to 7 zooecia in 5 mm.; budding at angle of about 30°. The branches are 2 mm. wide and divide at intervals of 6 mm.

Occurrence.—Devonian (Gaspé sandstone): Gaspé, Quebec.

Holotype.—U.S.N.M. No. 94576.

REPTARIA CAYUGA, new species

PLATE 16, FIGURE 2

Hederella sp. MONAHAN, Amer. Midl. Nat., vol. 12, No. 10, p. 389, pl. 3, fig. 3, 1931.

The type specimen of this new species, in the collection of the Buffalo Society of Natural History, consists of a natural mold or excavation in a cephalopod shell (*Mitroceras*) representing a species of *Reptaria* that differs from the genotype in the smaller dimensions of the zooecia, in their less regular arrangement, the lesser width of the branch, and the greater separation of the zooecia. The zooecia average 2 mm. in length, width 0.3 mm. bud at an angle of about 30°, and 6 occur in 5 mm.; the branches subdivide rather frequently at an angle of 45°, and average 2 mm. in width. This species, collected by the late Joseph W. Monahan, is interesting in being geologically the earliest known of the genus.

Occurrence.—Silurian (Cayugan-Bertie limestone): Quarries at Buffalo, N. Y.

Plastoholotype.—U.S.N.M. No. 87897.

REPTARIA CLOUDI, new species

PLATE 16, FIGURE 3

Compared with the genotype, this species is at once separated by its smaller dimensions both in the size of the tubes (average length 2 mm. and 0.3 mm. in width, with 4 in 5 mm.) and branches. The zoarium of the type specimen incrusts a cephalopod and consists of branches slightly less than 2 mm. in diameter, dividing rather regularly at an angle of about 70° at intervals of 7 mm. or more. Although approaching *R. cayuga* in general dimensions, the rectangular method of branching and the more closely and regularly arranged zooecia, separate the present form. The specific name is in recognition of the work of Preston Cloud on the faunas of the Middle Devonian of North America.

Occurrence.—Upper Devonian (Tully limestone-West Brook member): 2½ miles south of Sherburne, N. Y.

Holotype.—U.S.N.M. No. 87894.

Genus HERNODIA Hall, 1881

Hernodia Hall, Trans. Albany Inst., vol. 10, p. 196, 1883 (abstract, p. 196, 1881); Rep. State Geol. New York, 1883, p. 58, 1884—Hall and Simpson, Pal. New York, vol. 6, p. 26, 1887.—Miller, North Amer. Geol. Pal., p. 309, 1889.—Simpson, 14th Ann. Rep. State Geol. New York, 1894, p. 596, 1897.—Nickles and Bassler, U. S. Geol. Surv. Bull. 173, p. 21, 1900.

Nicholsonia Davis (part), Kentucky Foss. Corals, pt. 2, 1885 (name proposed but not defined). [Genotype: *N. canadensis* Davis (not Nicholson) = *Hernodia davisi* and *Hederella contortilis*, new species.]

This genus may be distinguished from *Hederella* by its elongate, club-shaped, annulated zooecia budding regularly from the middle of the lateral wall of the preceding zooecia, each in this manner giving rise to one or more daughter cells. At intervals rather constant for the species a bud inaugurates a new branch as in *Hederella*, and this in turn divides still further. Thus *Hernodia* may be considered as a *Hederella* with clavate zooecia arising from the middle portion of the preceding one. Besides the following species, *Hernodia* includes *H. počtai* Prantl, 1938, and *H. perminuta* Prantl, 1938, from the Silurian and Devonian, respectively, of Bohemia.

HERNODIA HUMIFUSA Hall, 1881

PLATE 15, FIGURES 5, 6

Hernodia humifusa Hall, Trans. Albany Inst., vol. 10, p. 196, 1883 (abstract, p. 196, 1881); Rep. State Geol. New York 1883, p. 58, 1884.—Hall and Simpson, Pal. New York, vol. 6, p. 281, pl. 65, figs. 20, 21, 1887.—Simpson, 14th Rep. State Geol. New York, 1894, pl. 25, figs. 1, 2, 1897.—Grabau and Shimer, North Amer. Index Foss., p. 120, 1907.—Bassler, *in* Cleland, Wisconsin Geol. Nat. Hist. Surv., Bull. 21, sci. ser. 6, p. 58, pl. 6, figs. 9, 10, 1911.

This, the genotype, is a robust, well-marked species, with zooecia 5 to 6 mm. in length, giving rise regularly toward the middle of each side at an angle of 45° to buds 0.25 mm. in diameter at their base, expanding gradually to the full width of the tube, 1 mm. Branching occurs rather regularly at distances sometimes of 15 mm. and at angles of 45° or less, so that the entire zoarium presents a graceful aspect.

Occurrence.—Middle Devonian: Cazenovia, etc. (Ludlowville shale), N. Y.; Milwaukee, Wis. (Milwaukee limestone).

Plesiotype.—U.S.N.M. Nos. 87885, 94623.

HERNODIA CORNUCOPIA, new species

PLATE 15, FIGURE 7

At first sight this well-developed species appears far removed from the genotype, but upon tracing the method of branching and the type of budding it is apparently a *Hernodia*, differing from typical species in that the branches are composed of tubes in close contact but arising in the normal manner on alternate sides from the midlength of the preceding tube. Although the type specimen is almost a solid mass of closely arranged tubes, branching occurs at intervals of about 10 mm. and at angles of about 45°, each branch starting with a single tube and, by its subdivision, increasing to a width of 10 mm., exhibiting 10 rows of zooecia before another bifurcation occurs. Each zooecium is distinctly horn-shaped, 3 to 4 mm. in length, and 1.3 mm. in width at its distal end, budding at such a low angle from the preceding one as to remain practically in contact. The apertures are terminal and elliptical; surface marked with very delicate transverse lines widely spaced.

Occurrence.—Middle Devonian (Traverse-Genshaw formation): Long Lake, Alpena, Mich.

Holotype.—U.S.N.M. No. 87886.

HERNODIA ULRICHI, new species

PLATE 15, FIGURE 8

Although evidently related to the genotype in method of budding and branching, this new species, named in honor of Dr. E. O. Ulrich, is separated at once by its smaller dimensions, the zooecia averaging only 3.5 mm. in length and 0.8 mm. in width. Furthermore, the zooecia expand more rapidly and bud at a greater angle (40°), while the branches subdivide at intervals of about 5 mm. at angles of more than 45°.

The type specimen, preserved as a siliceous cast of the interior, shows the specific characters very well, but a better-preserved example would form a most interesting fossil.

Occurrence.—Onondaga (Upper Jeffersonville limestone-*Spirifer acuminatus* bed): Falls of the Ohio.

Holotype.—U.S.N.M. No. 54128.

HERNODIA TENNESSEENSIS, new species

PLATE 15, FIGURE 1

Gutta-percha impressions of the type specimen, which is represented by an excavation in the base of a massive stony bryozoan, indicate a well-marked species that can be referred to only as a *Hernodia* with long zooecial tubes much narrowed in the proximal portion

whence budding proceeds. The zooecia are regularly 4 mm. long, including the narrow proximal part, and 0.6 mm. wide at their distal end. They emerge at a rather acute angle and bend slightly outward, remaining free but close together throughout their course, with 3 to 4 in 5 mm. Branching is also rather regular at intervals of about 6 mm. and at an angle of 45°.

This species shows considerable resemblance to *Reptaria*, differing mainly in that the zooecia bud on alternate sides instead of practically opposite each other.

Occurrence.—Helderbergian (Birdsong shale): Swaynes Mills, Benton County, Tenn.

Holotype.—U.S.N.M. No. 54127.

HERNODIA DAVISI, new species

PLATE 15, FIGURE 9

Nicholsonia canadensis DAVIS (not *Hederella canadensis* Nicholson), Kentucky Foss. Corals, pt. 2, pl. 51, fig. 6 (not pl. 80, fig. 15, or pl. 73, figs. 10, 11), 1885.

This interesting species forms featherlike incrustations upon brachiopod shells, where it covers areas of several centimeters in extent. Branching at intervals of 7 mm. or more and at an angle between 45° and 90° prevents the zooecia from forming compact masses. Each zooecial tube is distinct, curving slightly outward, and averages 2 mm. in length and 0.4 mm. in width, with about 3½ in 5 mm. Each arises at an angle of 25° on alternate sides of a prolonged central tube composed of the narrow proximal parts of the successive zooecia.

Closely allied to *H. tennesseensis* in zooecial dimensions, *H. davisi* can be distinguished by its loosely dividing branches, free tubes, and more distinctly developed central tube, in the last respect showing relations to *Hederella*.

Our figured specimen corresponds exactly with Davis' illustration, but a new name is necessary since his name *Nicholsonia canadensis* evidently referred to *Hederella canadensis* Nicholson.

Occurrence.—Middle Devonian: Falls of the Ohio (Silver Creek dolomite); 2 miles north of Arkona, Ontario (Widder shale).

Holotype.—U.S.N.M. No. 54118.

HERNODIA ? COOPERI, new species

PLATE 16, FIGURE 10

This well-marked species exhibits all the generic features of *Hernodia* except that the tubes have the thick walls and the nearly smooth surface characteristic of the Auloporidae. Its generic position is, therefore, doubtful, but at any rate it represents a distinct species.

Except for the wall structure, *H. ? cooperi* may be distinguished from other species of *Hernodia* by its short (2 mm.) rapidly expanding zooecia (0.6 mm. wide at distal end, budding at angle of 25°, with 2 to 3 in 5 mm.) and its branching at short but regular intervals (3 mm.) at an angle of more than 45°. With continued growth only a small opening is left between the branches, which disappear in old specimens leaving all the tubes in contact.

Occurrence.—Middle Devonian: Averys Creek, Erie County, N. Y. (Ludlowville-Wanakah shale); Rockport quarry, Alpena County (Traverse-Upper Ferron Point formation), 1.6 miles north of Norwood, Charlevoix County (Petoskey formation), Thunder Bay quarry, Alpena (Alpena limestone-Dock Street clay), all in Traverse group of Michigan.

Holotype.—U.S.N.M. No. 94586.

HERNODIA ? MONAHANI, new species

PLATE 15, FIGURE 3

Hederella cfr. *canadensis* MONAHAN, Amer. Midl. Nat., vol. 12, No. 10, p. 388, pl. 3, fig. 2, pl. 4, fig. 2, 1931.

This new species is named in honor of Joseph W. Monahan, whose early death lost to science an enterprising student of Devonian paleontology. It occurs as an excavation in the surface of a cephalopod (*Mitroceras*) preserved in the Museum of the Buffalo Society of Natural Sciences as No. 13342.

Gutta-percha squeezes of this mold indicate a well-marked species of either *Hederella* or *Hernodia*, which is of interest further in that it comes from Silurian rocks. As the illustration on plate 15 shows, the zooecia bud very regularly and alternately from a median axis, but the preservation is not good enough to enable one to determine whether this axis is formed of the caudal extremities of the tubes as in *Hernodia* or an elongate tube that gives rise on each side to buds as in *Hederella*.

In *H. ? monahani* branching is rather regular, at intervals of not less than 6 mm. and at angles of about 45°. The zooecia are small, cornucopia-shaped, bending outward in a curve, at an angle of 45°, averaging 1.3 mm. in length, 0.4 mm in width, and 4 in 5 mm. measuring along one side of the axis.

Occurrence.—Silurian (Cayugan-Bertie limestone): Near Buffalo, N. Y.

Plastoholotype.—U.S.N.M. No. 87883.

HERNODIA (?HEDERELLA) COMPACTA, new species

PLATE 15, FIGURE 4

Incrusting brachiopod shells in the Columbus limestone is a species belonging possibly to *Hederella*, characterized by the very compact arrangement of the zooecia. The few specimens available for study indicate a frequently branching *Hernodia* (angle of 60°–90°), in which the zooecial tubes bud from each other so frequently and at such a low angle that they remain practically in contact throughout their length. The tubes are 1½ to 2 mm. in length and 0.6 mm. in width, with 3 to 4 in 5 mm. They clearly originate alternately from about the midlength of the preceding zooecium at an angle of 30°.

Occurrence.—Onondaga (Columbus limestone): Sandusky, Ohio.

Holotype.—U.S.N.M. No. 54124.

FAUNAL LISTS SHOWING GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION

SILURIAN (Gotlandian): Island of Gotland.
Hederella siluriana, new species.

SILURIAN (Ludlow-Budnany limestone): Kosor, etc., Bohemia.
Hederella fruticosa (Počta, 1894); *H. formosa* Prantl, 1938; *Hernodia počtai* Prantl, 1938; *Reptaria steiningeri* (Barrande, 1868).

SILURIAN (Cayugan-Bertie limestone): Buffalo, N. Y.
Hernodia ? monahani, new species; *Reptaria cayuga*, new species.

HELDERBERGIAN (New Scotland limestone): Schoharie, Schoharie County, N. Y.
Hederella helderbergia, new species.

HELDERBERGIAN (New Scotland-Birdsong shale): Swaynes Mills (S), Perryville (P), and south of Camden (C), Tenn.
Hederella camdenensis, new species (C); *H. nodifera* new species (P); *Hernodia tennesseensis*, new species (S).

HELDERBERGIAN (50 feet below top): Big Stone Gap, Va.
Hederella ulrichi, new species.

ORISKANY SANDSTONE: Becraft Mountain near Hudson, N. Y.
Hederella arachnoidea Clarke, 1900; *H. gracilior* Clarke, 1900; *H. magna praecedens*, new variety; *H. ramea* Clarke, 1900.

ONONDAGA (Upper Jeffersonville limestone–*Spirifer acuminatus* bed): Falls of the Ohio at Louisville, Ky.
Hederella adnata (Davis, 1885); *H. angulata* (Davis, 1885); *H. consimilis*, new species; *H. contortilis*, new species; *H. delicatula*, new species; *H. louisvillensis*, new species; *H. tenera*, new species; *Hederopsis bifurcata*, new species; *H. connata*, new species; *H. curta*, new species; *H. longituba*, new species; *H. typicalis*, new species; *Hernodia ulrichi*, new species.

ONONDAGA (Columbus limestone): Sandusky, Ohio.
Hederella concinna, new species; *Hernodia (?Hederella) compacta*, new species.

ONONDAGA (Decewville limestone): Port Colborne, Ontario.
Hederella canadensis (Nicholson, 1874); *H. colbornensis*, new species.

ONONDAGA DRIFT: Vicinity of Ann Arbor, Mich.
Hederella canadensis (Nicholson, 1874).

DEVONIAN (Gaspé sandstone): Portage Road (P), Haldemand (H), and Gaspé (G), Quebec.

Hederella blainvillei Clarke, 1907 (P, H, G); *H. quebecensis*, new species (G); *Reptaria gaspéensis*, new species (G).

HAMILTON (Arkona shale): Arkona (A), Bartletts Mills (B), and 1 mile east of Marshs Mill (M), Ontario.

Hederella hibbardi, new species (A, M); *H. magna* Hall, 1881 (A); *H. thedfordensis*, new species (B).

HAMILTON (Widder shale): Arkona (A), Thedford (T), Bartletts Mills (B), Ontario.

Hederella bilineata, new species (A); *H. cirrhosa* Hall, 1881 (A, T); *H. concinna*, new species (A, T); *H. delicatula*, new species (A, T); *H. filiformis* (Billings, 1859) (A, T); *H. germana*, new species (T); *H. magna* Hall, 1881 (A. T); *H. major*, new species (T); *H. parallela*, new species (T); *H. parvirugosa*, new species (T, A, Marshs Mill, 2½ miles east of Arkona); *H. persimilis*, new species (T); *H. rectifurcata*, new species (T); *H. regularis* new species (T), *H. robusta* new species (T); *H. rugosa*, new species (A, T); *H. thedfordensis*, new species (A, B, T); *H. vagans*, new species (A, B, T); *Hernodia davisi*, new species (A); *Reptaria stolonifera* Rollé, 1851 (T).

HAMILTON (Ludlowville-Wanakah shale): 18-mile Creek (18), York (Y), Wanakah (W), Elma (E), Bay View (B), Athol Springs (A), Hamburg (H), Averys Creek (Av), Erie County in general (Er), N. Y.

Hederella bilineata, new species (18, Y); *H. cirrhosa* Hall, 1881 (Y, A, Er); *H. concinna*, new species (Er); *H. delicatula*, new species (18, Er); *H. filiformis* (Billings, 1859) (18, A); *H. magna* Hall, 1881 (B, Er); *H. nicholsoni*, new species (18, W, E, B, A); *H. parvirugosa*, new species (E); *H. persimilis*, new species (A); *H. rectifurcata*, new species (18, A); *H. reimanni*, new species (B, 18); *H. rugosa*, new species (Er); *H. thedfordensis*, new species (H, Av); *Hernodia ? cooperi*, new species (Av).

HAMILTON (Ludlowville shale exact zone indefinite): Kashong Creek (K), Skaneateles Lake (S), Canandaigua Lake (C), York (Y), West Bloomfield (W), Livingston County (L), Cazenovia (Ca), and Brookfield (B), N. Y.

Hederella bilineata, new species (Y); *H. cirrhosa* Hall, 1881 (W, Y, S); *H. concinna*, new species (K, L); *H. conferta* (Hall, 1881) (K, C); *H. delicatula*, new species (Y); *H. parvirugosa*, new species (S); *H. rectifurcata*, new species (K); *H. rugosa*, new species (C, Y); *H. thedfordensis*, new species K, L); *Hernodia humifusa* Hall, 1881 (Ca); *Reptaria stolonifera* Rollé, 1851 (K, Ca, B).

HAMILTON (Ludlowville-Centerfield shale): 3 miles west of East Bethany, N. Y.

Hederella bilineata, new species; *H. cirrhosa* Hall, 1881; *H. clarkei*, new species; *H. concinna*, new species; *H. concinnoides*, new species; *H. delicatula*, new species; *H. filiformis* (Billings, 1859); *H. magna* Hall, 1881; *H. nicholsoni*, new species; *H. parallela*, new species; *H. pavilionensis*, new species; *H. rectifurcata*, new species; *H. regularis*, new species; *H. robusta*, new species; *H. rugosa*, new species; *H. thedfordensis*, new species.

HAMILTON (Ludlowville-Tichenor limestone): 18-mile Creek (18), 1½ miles south of East Bethany (E), Darien (D), and near Pavilion (P), N. Y.

Hederella bilineata, new species (P, E); *H. cirrhosa* Hall, 1881 (E); *H. concinna*, new species (P, D, E); *H. delicatula*, new species (P, E); *H. filiformis* (Billings, 1859) (P, E); *H. magna* Hall, 1881 (P); *H. parallela*, new species (E); *H. parvirugosa*, new species (P); *H. obesa*, new species (18); *H. pavilionensis*, new species (P, E); *H. rectifurcata*, new species (E); *H. reimanni*, new species (P); *H. rugosa*, new species (P, E); *H. vagans*, new species (P, E).

HAMILTON (Moscow shale): Moscow (Windom) (M), 18-Mile Creek (18), Pavilion (P), Leicester (Windom) (L), Kashong Creek (Windom) (K), N. Y.

Hederella cirrhosa Hall, 1881 (P); *H. delicatula*, new species (M, K, L); *H. magna* Hall, 1881 (18); *H. parallela*, new species (M); *H. parvirugosa*, new species (M); *H. rugosa*, new species (M).

HAMILTON (Moscow-Kashong shale): Tile yard, 1½ miles southeast of East Bethany, N. Y.

Hederella filiformis (Billings, 1859); *H. parallela*, new species; *H. parvirugosa*, new species; *H. rectifurcata*, new species; *H. robusta*, new species; *H. rugosa*, new species; *H. thedfordensis*, new species.

MIDDLE DEVONIAN (Sellersburg limestone): Falls of the Ohio (F), Lebanon, Ky. (L), 3½ miles west of Charlestown, Ind. (C).

Hederella bilineata, new species (L); *H. cirrhosa* Hall, 1881 (C, Silver Creek dolomite); *H. delicatula*, new species (L); *H. michiganensis*, new species (F); *H. parvirugosa*, new species (C, Silver Creek); *Hernodia davisi*, new species (F, Silver Creek); *Reptaria stolonifera* Rollé, 1851 (F).

MIDDLE DEVONIAN (Milwaukee limestone-Lindwurm member): Milwaukee, Wis.

Hederella alpenensis, new species; *H. delicatula*, new species; *H. edwardsi*, new species; *H. filiformis* (Billings, 1859); *H. halyson* (Fenton and Fenton); *H. rectifurcata*, new species; *Hederopsis raaschi*, new species; *Hernodia humifusa* Hall, 1881; *Reptaria stolonifera* Rollé, 1851.

MIDDLE DEVONIAN (Silica shale): 2½ miles southwest of Sylvania, Ohio.

Hederella alpenensis, new species; *H. bilineata*, new species; *H. concinnoides*, new species; *H. delicatula*, new species; *H. filiformis* (Billings, 1859); *H. magna* Hall, 1881; *H. parvirugosa*, new species; *H. rectifurcata*, new species; *H. reimanni*, new species; *H. thedfordensis*, new species; *H. vagans*, new species; *Reptaria stolonifera* Rollé, 1851.

MIDDLE DEVONIAN (Traverse-Upper Bell shale): Rockport quarry, northeast corner of Alpena County, Mich.

Hederella filiformis (Billings, 1859); *H. nicholsoni*, new species.

MIDDLE DEVONIAN (Traverse-Upper Ferron Point formation): Abandoned shale pit of Alpena Portland Cement Co., SE¼ Sec. 18, T. 32 N., R. 9 E. (P), Rockport quarry (R), and Alpena Cement Co. (A), Alpena County, Mich.

Hederella alpenensis, new species (P); *H. delicatula*, new species (R); *H. filiformis* (Billings, 1859) (P, R); *H. michiganensis*, new species (R); *H. parvirugosa*, new species (P); *H. robusta*, new species (A); *Hernodia ? cooperi*, new species (R).

MIDDLE DEVONIAN (Traverse-Genshaw formation): Southwest shore of Long Lake, Alpena County (L), Alpena County (A), Mich.

Hederella alpenensis, new species (El Cajon Beach, L); *H. magniventra*, new species (A); *H. robusta*, new species (A); *H. romingeri*, new species (L); *H. thedfordensis*, new species (A); *Hernodia cornucopia*, new species (L).

MIDDLE DEVONIAN (Traverse-Alpena limestone): Alpena (A), ¼ mile northwest of Bolton, Alpena County (B), Thunder Bay quarry, Alpena (T, Dock Street clay), Mich.

Hederella alpenensis, new species (B); *H. delicatula*, new species (B, T); *H. filiformis* (Billings, 1859) (B); *H. magniventra*, new species (A, T); *H. michiganensis*, new species (B); *H. robusta*, new species (B); *H. rugosa*, new species (T); *H. thedfordensis*, new species (T); *Hernodia ? cooperi*, new species (T).

MIDDLE DEVONIAN (Traverse-Norway Point formation): ½ mile southeast of 4-Mile Dam, Alpena County (4), Thunder Bay River (T), and Norway Point Dam (N), Mich.

Hederella alpenensis, new species (4); *H. delicatula*, new species (4); *H. filiformis* (Billings, 1859) (4); *H. magniventra*, new species (T); *H. michiganensis*, new species (T); *H. persimilis*, new species (N); *H. robusta*, new species (N).

MIDDLE DEVONIAN (Traverse-Partridge Point formation): Partridge Point, about 3 miles south of Alpena, Mich.

Hederella cirrhosa Hall, 1881; *H. compacta*, new species; *H. delicatula*, new species; *H. persimilis*, new species; *H. rugosa*, new species.

MIDDLE DEVONIAN (Traverse-Gravel Point limestone): Petoskey Cement Co., Petoskey, (P), Bell Quarry, 2.1 miles east of Bayshore, Emmet County (E), Charlevoix (Ch), and Bay View (B), Mich.

Hederella alpenensis, new species (P, B); *H. concinna*, new species (B, E); *H. delicatula*, new species (P); *H. magniventra*, new species (P, Ch); *H. michiganensis*, new species (B); *H. persimilis*, new species (P, B, Ch); *H. rectifurcata*, new species (P).

MIDDLE DEVONIAN (Traverse-Petoskey formation): 1½ miles northeast of Bay View (B), and 1.6 miles north of Norwood, Charlevoix County (N), Mich.

Hederella concinna, new species (B); *H. delicatula*, new species (B, N); *H. filiformis* (Billings, 1859) (B, N); *H. michiganensis*, new species (N); *H. persimilis*, new species (N); *H. robusta*, new species (B, N); *H. rugosa*, new species (B); *Hernodia ? cooperi*, new species (N).

UPPER DEVONIAN (Tully limestone–West Brook member): 2½ miles south of Sherburne, N. Y.

Hederella aequidistans, new species; *Reptaria cloudi*, new species.

DEVONIAN (Cedar Valley formation): Iowa City (I), Davenport (D), Buffalo (B), and near Randalia (R), Iowa.

Hederella calvini, new species (D); *H. crassilinea*, new species (I, R); *H. halyson* (Fenton and Fenton, 1924) (B).

DEVONIAN (Hackberry–Cerro Gordo shale): Rockford and vicinity, Iowa.

Hederella alternata (Hall and Whitfield, 1873); *H. halyson* (Fenton and Fenton, 1924); *H. linearis* (Fenton and Fenton, 1924).

DEVONIAN (Snyder Creek shale): Fulton, Mo.

Hederella crassilinea, new species; *H. triseriata*, new species.

DEVONIAN: 40 miles above mouth of Hay River, Canada.

Hederella ? laxa (Whiteaves, 1891).

DEVONIAN (Percha shale): Lake Valley, N. Mex.

Hederella occidentalis, new species.

MIDDLE DEVONIAN: Taemas, south side of Murrumbidgee River, New South Wales.

Hederella brownae, new species.

DEVONIAN: Bohemia.

Hederella obscura Prantl, 1938 (Koniepruss limestone at Suchomasty); *Hernodia perminuta* Prantl, 1938 (Branik limestone, Branik); *Reptaria gigas* Prantl, 1938 (Branik limestone, Karlstejn).

DEVONIAN (Oberkoblenzian): Near Coblenz, Germany.

Hederella applicata Solle, 1937; *H. rhenana* Solle, 1937.

MISSISSIPPIAN (Warsaw limestone): Warsaw, Ill.

Hederella varsoviensis, new species.

MISSISSIPPIAN (Chester): Smithland (S), east of Grayson Springs Station (G), Sloans Valley (S1), Marion (M), Stephensport (St), Ky. (Glen Dean limestone), Chester, Ill. (C), Evansville, Ind. (E).

Hederella chesterensis, new species (C, E, S, G, S1, M, St).

TABLE 1.—*Average measurements of* Hederelloidea *described herein*

(The species of each genus are arranged on the basis of zooecial width as the most convenient factor for identification and comparison)

NAME	ILLUSTRATION	ZOOECIAL WIDTH	ZOOECIAL LENGTH	ZOOECIA IN 5 MM.	ANGLE OF BUDDING	INTERVAL OF BRANCHING	ANGLE OF BRANCHING
HEDERELLA:		*Mm.*	*Mm.*			*Mm.*	
regularis	Pl. 8, figs. 1–2	0.15	0.6	6	45°	3–5	----------
concinnoides	Pl. 11, fig. 9	0.15	1	5	60°	2.5	60°
delicatula	Pl. 11, figs. 1–8	0.15	0.8	4–5	45°	1.5–6	90°
canadensis	Pl. 7, figs. 2–4	0.2	0.7	3–4	Acute	5	30°
consimilis	Pl. 5, fig. 12	0.2	1.0	6	25°	4½	90°
arachnoidea	Pl. 13, fig. 7	0.25	1.3	4	35°	5	90°
tenera	Pl. 7, figs. 7–9	0.25	1.3	3	45°	1.5–2	45°
colbornensis	Pl. 7, fig. 1	0.3	1.25	4–5	Acute	4	60°
concinna	Pl. 7, figs. 10–15; pl. 15, fig. 2.	0.3	0.75	5–6	30°	5	90°
cirrhosa	Pl. 6, figs. 1–8	0.3	1.5	2–3	30–45°	7½	----------
angulata	Pl. 7, figs. 5, 6	0.3	0.5	1–2	45°	1.5–3	90°
rectifurcata	Pl. 7, fig. 16	0.3	Short	2–3	90°	3	About 90°
chesterensis	Pl. 6, figs. 9–11	0.3	2.5	3	45°	----------	45–60°
bilineata	Pl. 5, fig. 9	0.3	1.0	5–6	Acute	3	60–90°
aequidistans	Pl. 9, fig. 6	0.3	2	2–3	Acute	3	90°
helderbergia	Pl. 8, fig. 3	0.35	2	3	45°	4–5	----------
alternata	Pl. 5, figs. 1–3	0.35	1	4	45°	3½	90°
linearis	Pl. 5, figs. 6, 7	0.35	1.2	3	30°	6½	60°
ramea	Pl. 13, fig. 10	0.35	3	----------	30°	3	30°
conferta	Pl. 9, figs. 4, 5	0.35	2	3	About 45°	4	45°
clarkei	Pl. 10, fig. 3	0.35	1.5	4	Acute	3	45°
parallela	Pl. 2, figs. 1–2	0.35	2	2½–3	Acute	8	About 45°
varsoviensis	Pl. 9, fig. 1	0.35	2	2–3	Acute	3	30°
parvirugosa	Pl. 6, figs. 12–14	0.35	1	4	45°	7	----------
siluriana	Pl. 13, fig. 3	0.4	1–2	----------	90°	2	90°
vagans	Pl. 4, figs. 1, 2	0.4	1	2	30–45°	15+	----------
contortilis	Pl. 8, figs. 5–8	0.4	1.5	3	50–60°	3	50°
alpenensis	Pl. 3, figs. 1–6	0.4	1.1	4–5	Acute	3½	60°
calvini	Pl. 9, fig. 2	0.4	2	2½	Acute	5	30°
louisvillensis	Pl. 5, fig. 8	0.4	1.5	4	About 25°	10	About 50°
triseriata	Pl. 2, fig. 3	0.4	1.6	3	About 25°	----------	45°
filiformis	Pl. 1, figs. 1–6	0.5	1	4	45°	5.5	90°
brownae	Pl. 1, fig. 13	0.5	1.6	4	45°	3	60°
germana	Pl. 4, fig. 6	0.5	1.6	1–2	Acute	12	90°
occidentalis	Pl. 6, fig. 15	0.5	1.5	----------	60–90°	3	50–60°
camdenensis	Pl. 6, fig. 16	0.5	1.6	3	45°	----------	----------
blainvillei	Pl. 13, fig. 6	0.5	2–3	----------	30°	4	30°
pavilionensis	Pl. 4, fig. 5	0.5	2–4	----------	30°	----------	45°
gracillor	Pl. 3, fig. 12	0.5	1.5	3–3½	Acute	6–7	60°
persimilis	Pl. 2, figs. 4, 5	0.5	2	3	30°	6	About 45°
romingeri	Pl. 9, fig. 3	0.5	2.2	About 3	Acute	5	About 20°
halyson	Pl. 5, figs. 4, 5; pl. 2, fig. 6; pl. 12, fig. 1.	0.55	2	3	25°	----------	60°
crassilinea	Pl. 4, fig. 4; pl. 13, figs. 4, 5.	0.6	1.3	2½–3	45°	5–10	90°
nicholsoni	Pl. 4, figs. 8, 8′; pl. 12, fig. 4.	0.6	2	2½–3	35°	5–6	45°—

TABLE 1.—*Average measurements of* Hederelloidea *described herein*—Continued

NAME	ILLUSTRATION	ZOOECIAL WIDTH	ZOOECIAL LENGTH	ZOOECIA IN 5 MM.	ANGLE OF BUDDING	INTERVAL OF BRANCHING	ANGLE OF BRANCHING
HEDERELLA—Con.		*Mm.*	*Mm.*			*Mm.*	
nodifera	Pl. 12, fig. 3	0.6	3		Acute		Acute
quebecensis	Pl. 13, fig. 9	0.6	2			4	
adnata	Pl. 11, figs. 10–12	0.6	2.5	2	30°	5	
edwardsi	Pl. 4, fig. 7	0.6	2.5	2	About 20°	6	About 30°
?laxa	Pl. 13, fig. 1	0.65	1.2			3.5	45°—
rugosa	Pl. 2, fig. 7; pl. 3, figs. 7, 8.	0.6–0.7	2	3	20°	4	40°
ulrichi	Pl. 13, fig. 8	0.7	2	2½	Less than 45°	10	
thedfordensis	pl. 1, figs. 7–12; pl. 13, fig. 2.	0.7	2.5	2	30°		60°
hibbardi	Pl. 4, figs. 3, 3′	0.7	2.5	2½–3	Acute	4	About 20°
compacta	Pl. 5, fig. 13	0.7	1.5	4–4½	Acute		20°—
magniventra	Pl. 10, figs. 5, 6	0.75	1–2	2½–3			90°
michiganensis	Pl. 10, figs. 1, 1′; pl. 12, fig. 5.	0.8	2	2	45°+	4	90°
magna	Pl. 3, figs. 9, 10	1	2.2	2–2.5	About 20°	20	60–90°
magna praecedens.	Pl. 3, fig. 11	1	2	3	Acute	15—	45°
obesa	Pl. 10, fig. 4	1	2.7	2–2.5	Acute	10–12	45°
reimanni	Pl. 12, fig. 8	1	4	About 1	Acute	10	90°
robusta	Pl. 10, fig. 2; pl. 12, figs. 6, 7.	1.2	3	2	30°	6	45°
major	Pl. 8, fig. 4	1.5	4	2	Acute		45°
HEDEROPSIS:							
bifurcata	Pl. 14, fig. 9	0.35	3–4	About 2	Acute	5–6	30°
curta	Pl. 14, fig. 7	0.66	1.5	2–3	Acute	6	About 30°
longituba	Pl. 14, fig. 8	0.66	4	1–2	Acute	6	30°
raaschi	Pl. 14, fig. 1	0.7	2.5	2	25°	5	About 60°
connata	Pl. 14, fig. 10	1	4–5	1–2	45°	6	About 45°
typicalis	Pl. 14, figs. 2–6	1.3	3	3–4	About 45°	5	About 45°
REPTARIA:							
cayuga	Pl. 16, fig. 2	0.3	2	6	30°	2	About 45°
cloudi	Pl. 16, fig. 3	0.3	2	4	45°	7	70°
stolonifera	Pl. 16, figs. 4–8	0.5	3	5–6	45°—	Long	45–60°
gaspéensis	Pl. 16, fig. 1	0.5	1.5	6–7	30°	6	About 45°
HERNODIA:							
davisi	Pl. 15, fig. 9	0.4	2	3½	About 25°	7	45–90°
?monabani	Pl. 15, fig. 3	0.4	1.3	4	45°	6	45°
tennesseensis	Pl. 15, fig. 1	0.6	4	3–4	Acute	6	45°
?cooperi	Pl. 16, fig. 10	0.6	2	2–3	25°	3	45°
compacta	Pl. 15, fig. 4	0.6	1½–2	3–4	30°		60–90°
ulrichi	Pl. 15, fig. 8	0.8	3.5	1–2	About 40°	5	45°
humifusa	Pl. 15, figs. 5–6	1	5–6	About 1	45°	15	45°
cornucopia	Pl. 15, fig. 7	1.3	3–4	1½	Acute	10	45°

PLATES

(All figures are magnified × 4 unless otherwise indicated.)

139917—39——5

Plate 1

Page

1–6′. *Hederella filiformis* (Billings, 1859)---------- 35

1, 2, A colony two-thirds natural size growing upon *Spirifer mucronatus thedfordensis*, and a portion enlarged (after Nicholson).

3, A typical example exhibiting the main axis with branches arising at almost a right angle and short, broad zooecia budding from each at 45°.

4, Portion of same, × 8, showing the zooecial budding and surface in more detail.

5, Another example with slightly longer zooecial tubes, which tend to coil.

Hamilton (Widder shale), Thedford, Ontario.

6, A Wisconsin specimen identified with this species.

Middle Devonian (Milwaukee limestone-Lindwurm member), Milwaukee, Wis.

6′, A Michigan example illustrating more frequent branching than usual.

Traverse (Ferron Point formation), Rockport quarry, Alpena County, Mich.

7–12. *Hederella thedfordensis*, new species (see also pl. 13, fig. 2)---------- 43

7, A colony with ancestrula incrusting a *Tropidoleptus*, showing the coarsely lined tubes budding rather irregularly.

8, Ancestrular part of same colony, × 8; the suture line marking the budding points is quite visible.

Hamilton (Moscow-Kashong shale), Tile Factory, 1½ miles southeast of East Bethany, N. Y.

9, An example illustrating budding of two short zooecia at intervals, from each side of the main axis and its branches.

Middle Devonian (Silica shale): 2½ miles southwest of Sylvania, Lucas County, Ohio.

10, Basal part of a zoarium in which frequent branching has produced a compact colony.

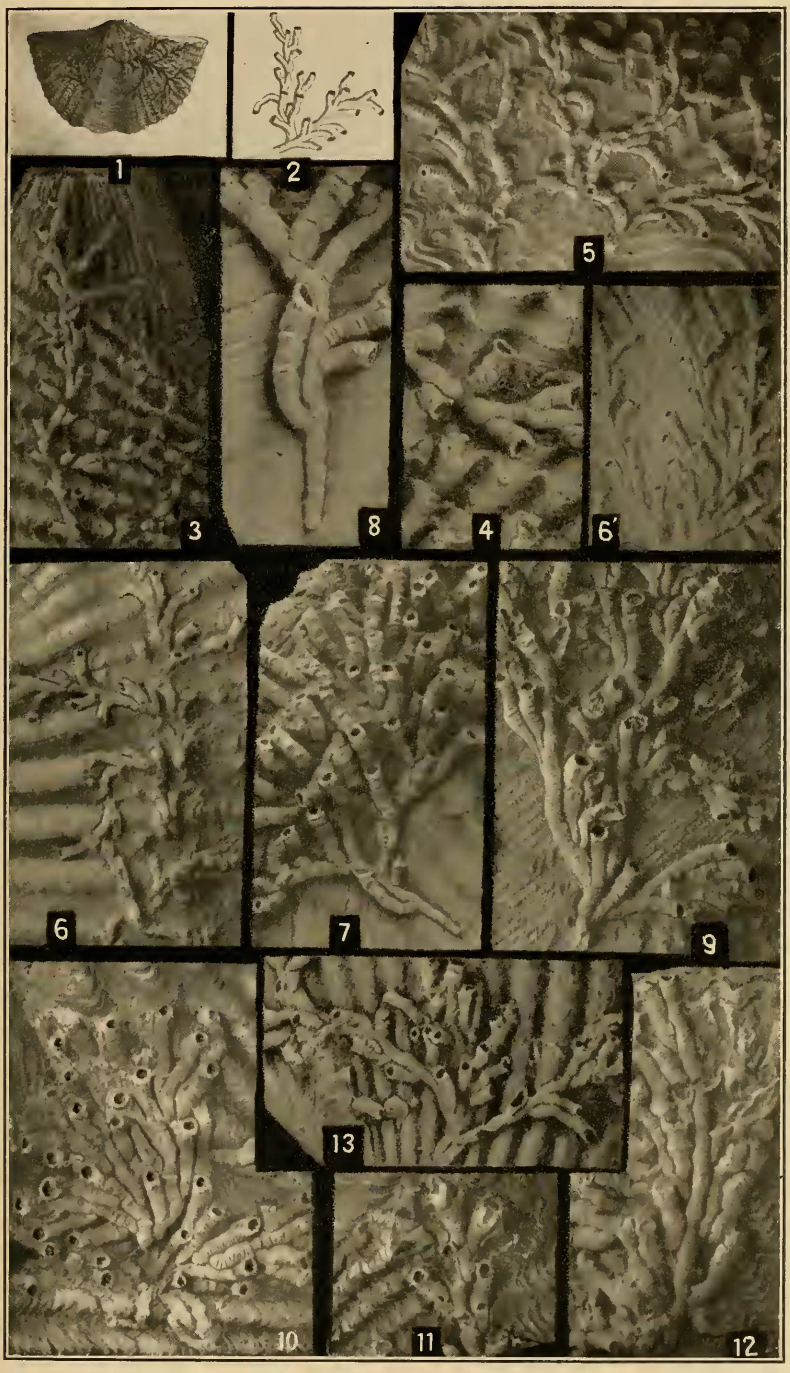
11, Part of the main axis of a colony incrusting a *Spirifer mucronatus thedfordensis* in which branching has not obscured the details of zooecial budding.

12, Portion of a colony with the main axis especially well developed.

Hamilton (Widder shale), Thedford, Ontario.

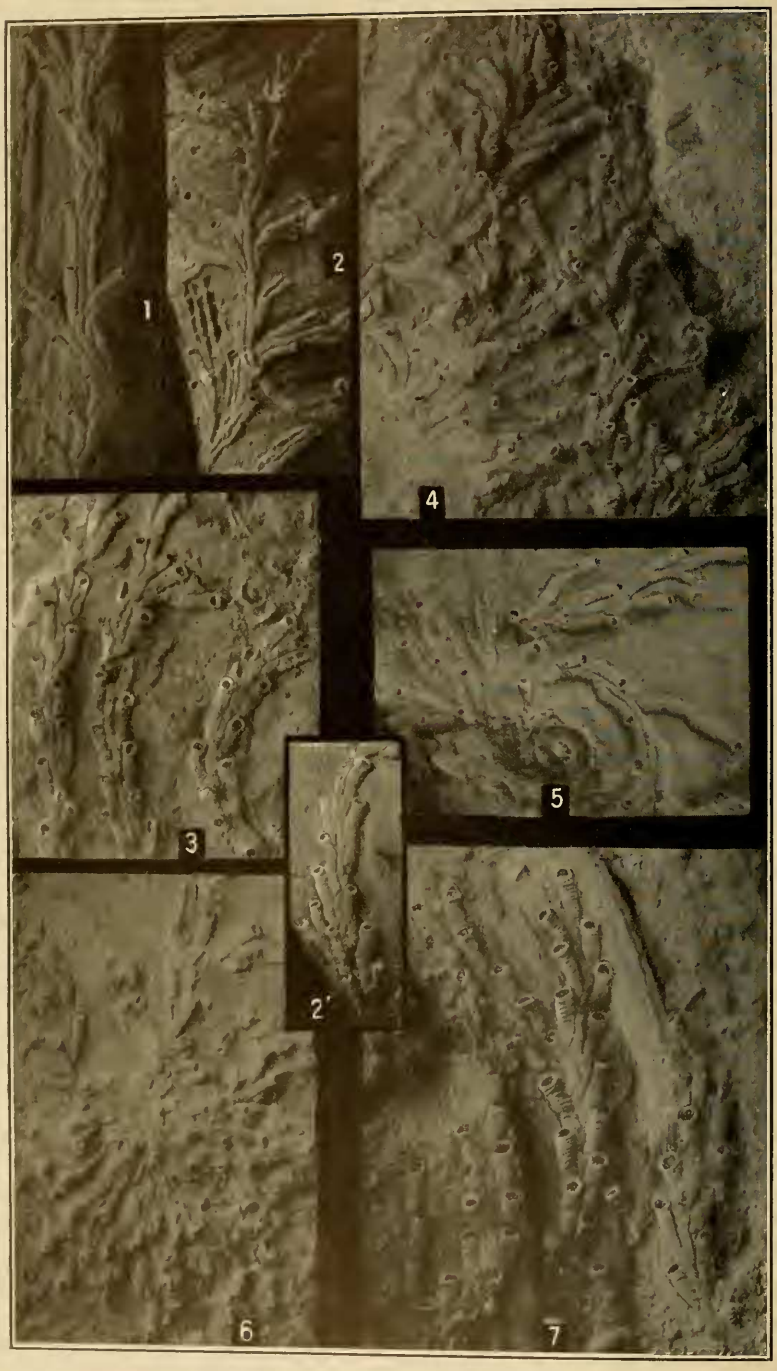
13. *Hederella brownae*, new species: Portion of the type incrusting a *Spirifer*---------- 36

Middle Devonian: Taemas, south side of Murrumbidgee River, New South Wales.



SPECIES OF HEDERELLA.

FOR EXPLANATION SEE OPPOSITE PAGE.



SPECIES OF HEDERELLA.

FOR EXPLANATION SEE OPPOSITE PAGE.

Plate 2

Page

1–2′. *Hederella parallela*, new species 55

1, Portion of a zoarium incrusting a cup coral (*Heliophyllum*) showing the main axis and several branches composed of zooecial tubes almost parallel to one another.

Hamilton (Ludlowville–Tichenor limestone), 1½ miles south of East Bethany, N. Y.

2. Portion of a main branch incrusting a terebratuloid shell.

Hamilton (Widder shale), Thedford, Ontario.

2′, Another example incrusting a coral in which the main axes of two colonies cross each other.

Hamilton (Moscow shale), Moscow, N. Y.

3. *Hederella triseriata*, new species 58

The type zoarium incrusting a *Stropheodonta*, showing a portion with parallel branches with zooecia in contact and broader than in the related *H. parallela*.

Devonian (Snyder Creek shale), Fulton, Mo.

4, 5. *Hederella persimilis*, new species 49

4, An example in which overlapping of the branches has produced a complex zoarium.

Middle Devonian (Traverse–Gravel Point limestone), Bay View, Mich.

5, Young zoarium illustrating method of branching and budding.

Middle Devonian (Traverse–Lower Gravel Point limestone), Petoskey Cement Co., Petoskey, Mich.

6. *Hederella halyson* (Fenton and Fenton, 1924) (see also pl. 5, figs. 4, 5, and pl. 12, fig. 1) 48

Base of a zoarium with ancestrular portion much obscured but with radiating branches showing the typical structure.

Devonian (Cedar Valley formation), Buffalo, Iowa.

7. *Hederella rugosa*, new species (see also pl. 3, figs. 7, 8) 49

A well-developed example incrusting *Heliophyllum*.

Hamilton (Widder shale), Thedford, Ontario.

Plate 3

Page

1–6. *Hederella alpenensis*, new species 47

1, An example with branching more frequent than usual.

Middle Devonian (Traverse-Genshaw formation), Long Lake, near Alpena, Mich.

2, Basal portion of colony with details of growth obscured by branching and overlapping of tubes.

Middle Devonian (Traverse-Norway Point formation), 7-Mile Dam, Alpena County, Mich.

3, A small colony with branches crossing one another.

4, A colony illustrating the typical method of branching and budding of the tubes.

5, Portion of fig. 4, × 8, indicating surface ornamentation and budding of tubes in more detail.

Devonian (Traverse-Genshaw formation), near El Cajon Beach, Alpena County, Mich.

6, Youthful stage with initial branching almost at right angles.

Middle Devonian (Traverse-Gravel Point limestone), Petoskey Cement Co., Petoskey, Mich.

7, 8. *Hederella rugosa*, new species (see also pl. 2, fig. 7) 49

7, A colony illustrating the ancestrula, the rugose tubes arising from it succeeded by the normal, broader, less wrinkled zooecia.

8, The initial stage of the same colony, × 8.

Hamilton (Ludlowville-Wanakah shale), Erie County, N. Y.

9, 10. *Hederella magna* Hall, 1881 51

9, The original illustration of this species (after Hall and Simpson).

10, A branch showing the large, short, wide, and rapidly expanding zooecia with flaring apertures.

Hamilton (Ludlowville-Wanakah shale), Erie County, N. Y.

11. *Hederella magna praecedens*, new variety 52

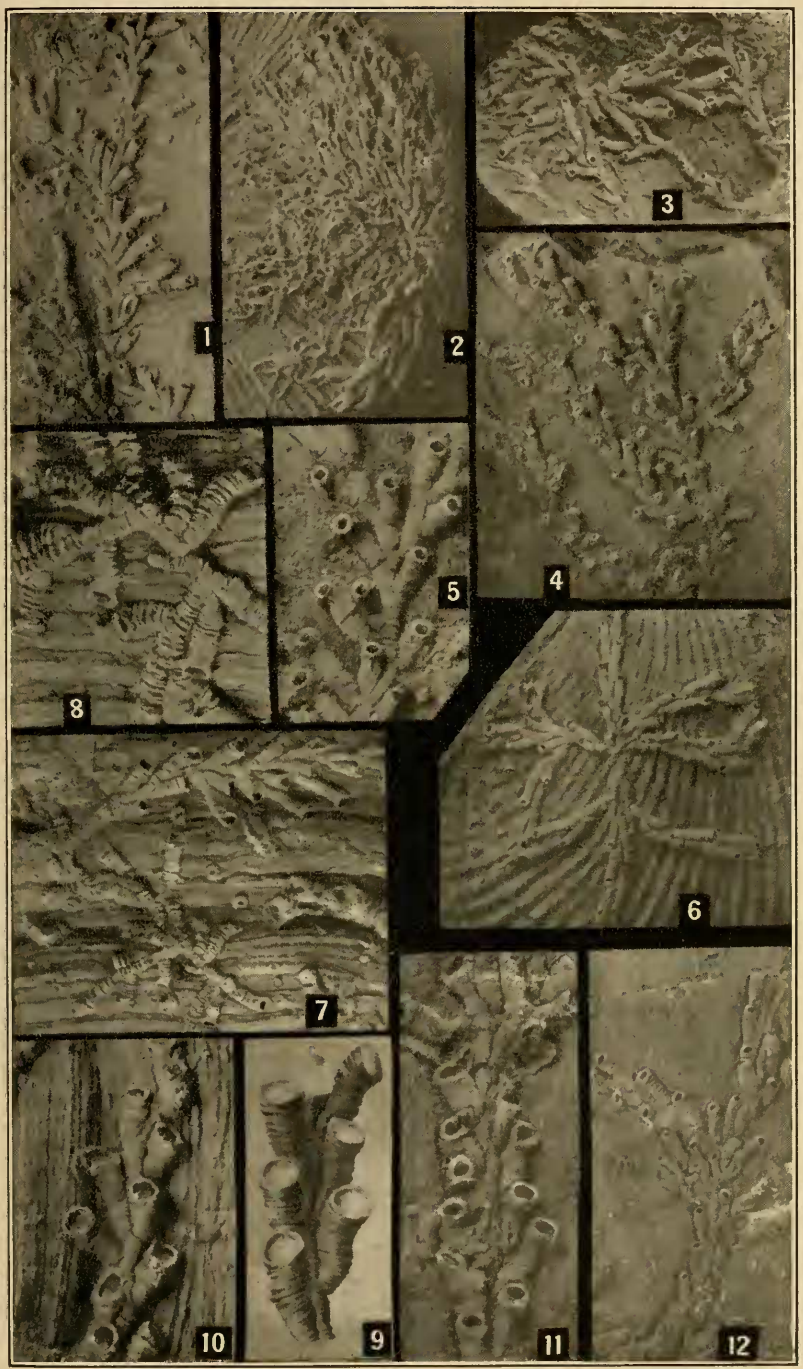
Photograph of Clarke's figured specimen of *H. magna* distinguished by its shorter broad tubes with even diameter.

Oriskany: Becraft Mountain, near Hudson, N. Y.

12. *Hederella gracilior* Clarke, 1900 48

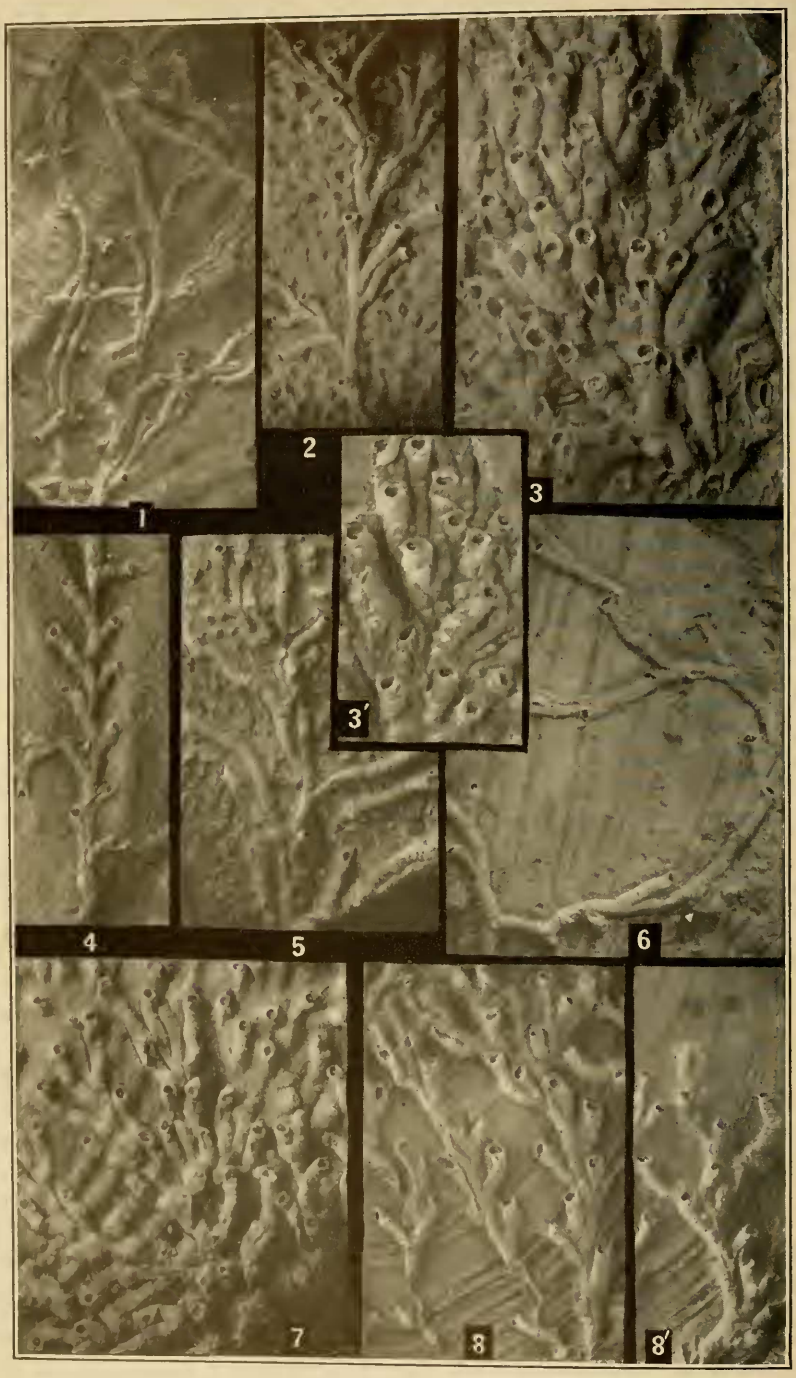
Photograph of the type illustrating the budding of the zooecia and the method of branching.

Oriskany: Becraft Mountain, near Hudson, N. Y.



SPECIES OF HEDERELLA.

FOR EXPLANATION SEE OPPOSITE PAGE.



SPECIES OF HEDERELLA.

FOR EXPLANATION SEE OPPOSITE PAGE.

PLATE 4

Page

1, 2. *Hederella vagans*, new species 38
1, Portion of the loosely growing incrusting colony with the main axis a single tube branching at long, infrequent intervals.
2, Small part of another example, showing more frequent branching.
Hamilton (Widder shale), Thedford, Ontario.

3, 3′. *Hederella hibbardi*, new species 55
3, The type specimen incrusting *Spirifer mucronatus arkonensis*, a colony of short, wide, swollen zooecia with branches closely arranged.
3′, Portion of another example, showing strong rugosities.
Hamilton (Arkona shale), Arkona, Ontario, and vicinity.

4. *Hederella crassilinea*, new species (see also pl. 13, figs. 4, 5) 41
The holotype incrusting a cup coral and showing the linear main axis branching at right angles at considerable intervals and with short, thick zooecia budding at an angle of 45°.
Devonian (Snyder Creek shale), Fulton, Mo.

5. *Hederella pavilionensis*, new species 43
Colony incrusting a *Fistulipora*, resembling *H. vagans* but differing in its wider, longer zooecia.
Hamilton (Tichenor shale), Pavilion, N. Y.

6. *Hederella germana*, new species 39
The type incrusting *Heliophyllum*, the zoarium differing from *H. vagans* in the wider branches and the larger angle of bifurcation.
Hamilton (Widder shale), Thedford, Ontario.

7. *Hederella edwardsi*, new species 48
Portion of a very complete colony incrusting a *Spirifer* with the characteristic short, wide, frequently budding zooecia and the branches dividing at short intervals.
Middle Devonian (Milwaukee limestone-Lindwurm member), Milwaukee, Wis.

8, 8′. *Hederella nicholsoni*, new species (see also pl. 12, fig. 4) 44
Two portions of the holotype incrusting *Athyris spiriferoides* and illustrating differences in the method of division of the branches and the rise of the zooecia at angles of about 45°.
Hamilton (Ludlowville-Wanakah shale), 18-Mile Creek, N. Y.

Plate 5

Page

1–3. *Hederella alternata* (Hall and Whitfield, 1873) 36

1, A small complete zoarium incrusting a *Spirifer* and showing the ancestrula, the method of branching, and the regular alternate budding of the zooecia.

2, More mature portion of another zoarium with branching and budding plan quite visible.

3, A slightly abraded example.

Devonian (Hackberry–Cerro Gordo shale), Rockford, Iowa.

4, 5. *Hederella halyson* (Fenton and Fenton, 1924) (see also pl. 2, fig. 6, and pl. 12, fig. 1) 48

4, Incomplete small zoarium incrusting a *Spirifer*.

5, A small colony illustrating the budding of the short tube directly from the short preceding one.

Devonian (Hackberry–Cerro Gordo shale), Rockford, Iowa.

6, 7. *Hederella linearis* (Fenton and Fenton, 1924) 37

6, A zoarium incrusting a *Spirifer* and showing the similar angle of branching and budding.

7, Portion of a colony illustrating the short but rather wide zooecial tube.

Devonian (Hackberry-Cerro Gordo shale), Rockford, Iowa.

8. *Hederella louisvillensis*, new species 57

A colony incrusting the interior of a brachiopod shell, illustrating similarity to *H. bilineata* but differing in the larger size of the zooecia.

Onondaga (Upper Jeffersonville limestone), Falls of the Ohio.

9–11. *Hederella bilineata*, new species 56

9, Zoarium with ancestrula incrusting a brachiopod; the small bilinearly arranged zooecia and the regular branching of the zoarium are evident.

Hamilton (Ludlowville-Centerfield shale), 3 miles west of East Bethany, N. Y.

10, 11, Two portions of a zoarium incrusting a cup coral; the zoarial branching is at greater intervals than in the preceding, owing perhaps to the rough surface.

Hamilton (Ludlowville shale), York, N. Y.

12. *Hederella consimilis*, new species 57

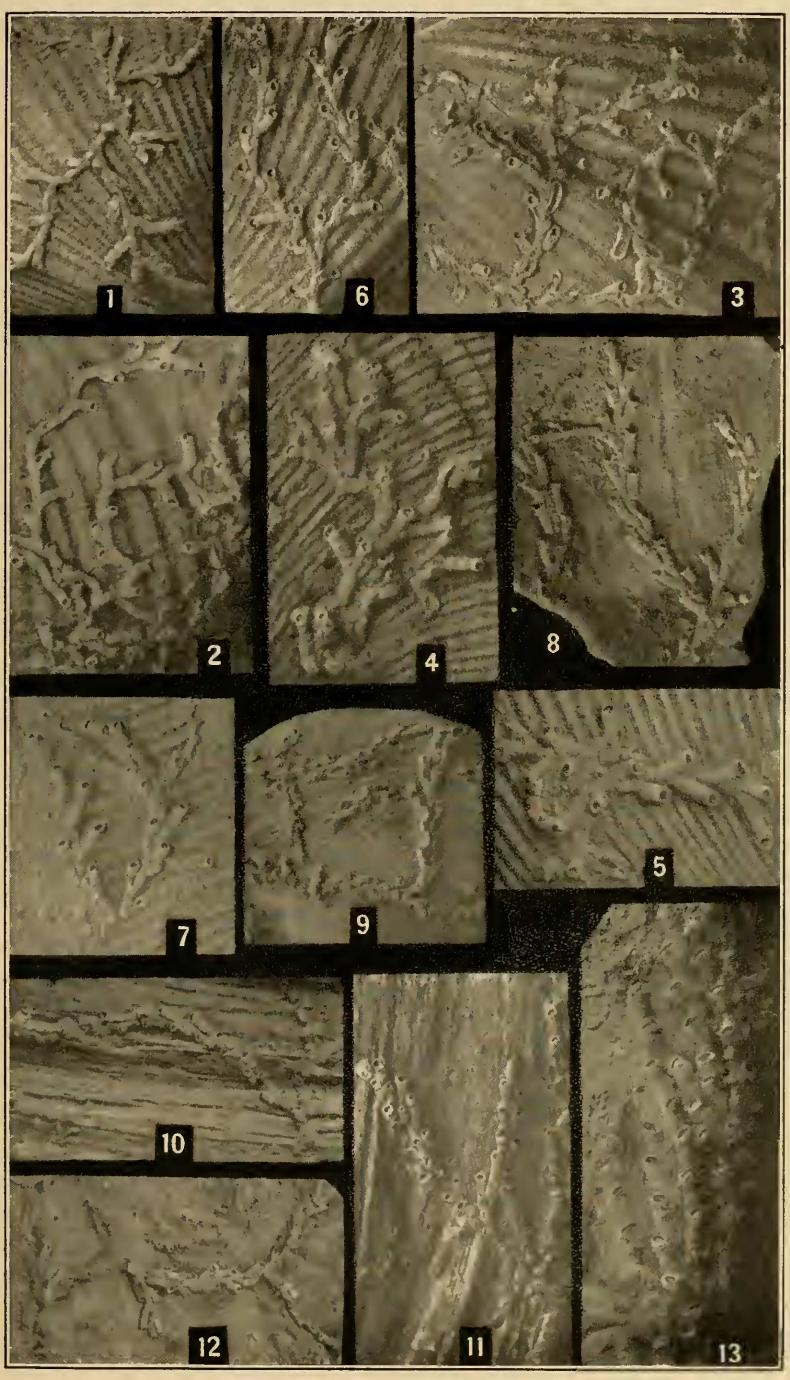
The type specimen incrusting the interior of a brachiopod, showing similarity to *H. bilineata* but with slightly longer and narrower zooecia.

Onondaga (Upper Jeffersonville limestone), Falls of the Ohio.

13. *Hederella compacta*, new species 56

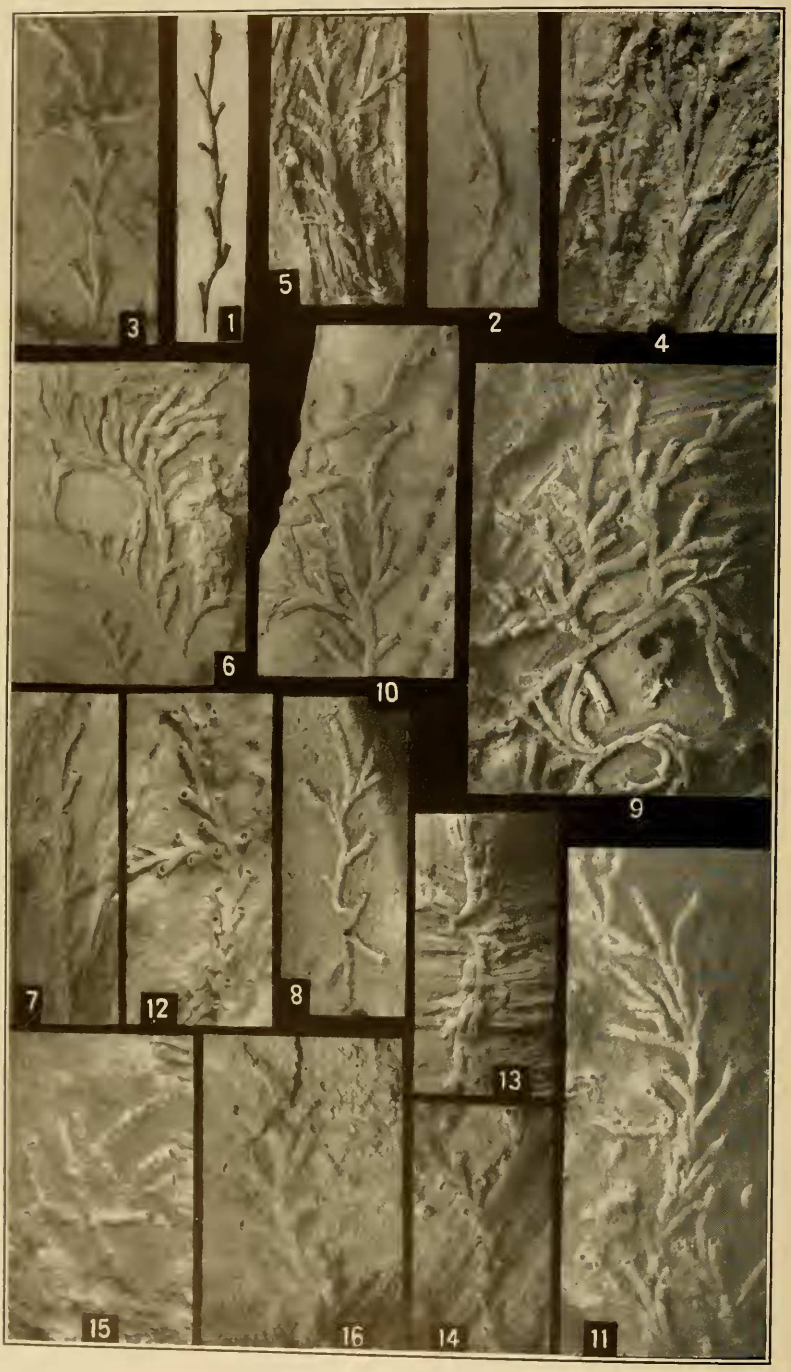
Zoarium incrusting a crinoid column; the closely spaced branches of short, wide, compactly arranged zooecia are evident.

Middle Devonian (Traverse-Partridge Point formation), Partridge Point, 3 miles south of Alpena, Mich.



SPECIES OF HEDERELLA.

FOR EXPLANATION SEE OPPOSITE PAGE.



SPECIES OF HEDERELLA.

FOR EXPLANATION SEE OPPOSITE PAGE.

Plate 6

Page

1–8. *Hederella cirrhosa* Hall, 1881 34

1, The type specimen (after Hall and Simpson).

2, Photograph of a cast of the type.

Hamilton (Ludlowville shale), West Bloomfield, N. Y.

3, An example with long intervals between the zooecia.

4, Portion of a zoarium with crowded branches and unusually long tubes.

Hamilton (Ludlowville-Centerfield limestone), 3 miles west of East Bethany, N. Y.

5, A specimen referred doubtfully to the species but differing in the shorter intervals between the zooecia.

Hamilton (Ludlowville-Wanakah shale), Erie County, N. Y.

6, Part of a zoarium with budding developed on one side only, reducing the distance between the zooecia but showing the normal arrangement on one of the branches.

Hamilton (Widder shale), Arkona, Ontario.

7, An example similar to the original type but with less distance between the zooecia.

Hamilton (Ludlowville shale), Skaneateles Lake, N. Y.

8, Specimen with ancestrula and illustrating the less regular growth in the young stages.

Middle Devonian (Silver Creek dolomite), Charlestown, Ind.

9–11. *Hederella chesterensis*, new species 46

9, One of the types, illustrating the main axis giving rise to branches of single zooecia that curve and bud into characteristic groups.

10, An example incrusting a *Lyropora* showing the outer branches of the zoarium.

11, An elongate branch incrusting a cup coral in which the curved aspect of the groups is not so apparent.

Chester group: Marion (9) and Sloans Valley (11), Ky. (Glen Dean limestone), and Evansville, Ind. (10).

12–14. *Hederella parvirugosa*, new species 33

12, Portion of zoarium exhibiting the method of division of both zooecia and branches.

Hamilton (Widder shale), Thedford, Ontario.

13, Ancestrula and young zooecia.

Hamilton (Ludlowville-Wanakah shale), Elma, N. Y.

14, Portion of a mature colony, illustrating usual budding of zooecia and branching.

Hamilton (Moscow shale), Moscow, N. Y.

15. *Hederella occidentalis*, new species 41

The type specimen, a worn zoarium but distinct enough for description.

Devonian (Percha shale), Lake Valley, N. Mex.

16. *Hederella camdenensis*, new species 41

The somewhat abraded type specimen characterized by its stout linear branch with widely divergent zooecia.

Lower Devonian (Helderbergian-Birdsong shale), just south of Camden, Tenn.

Plate 7

Page

1. *Hederella colbornensis*, new species 32
 Gutta-percha impression of the type, a zoarium incrusting a cup coral.
 Middle Devonian (Onondaga–Deerwville limestone), Port Colborne, Ontario.

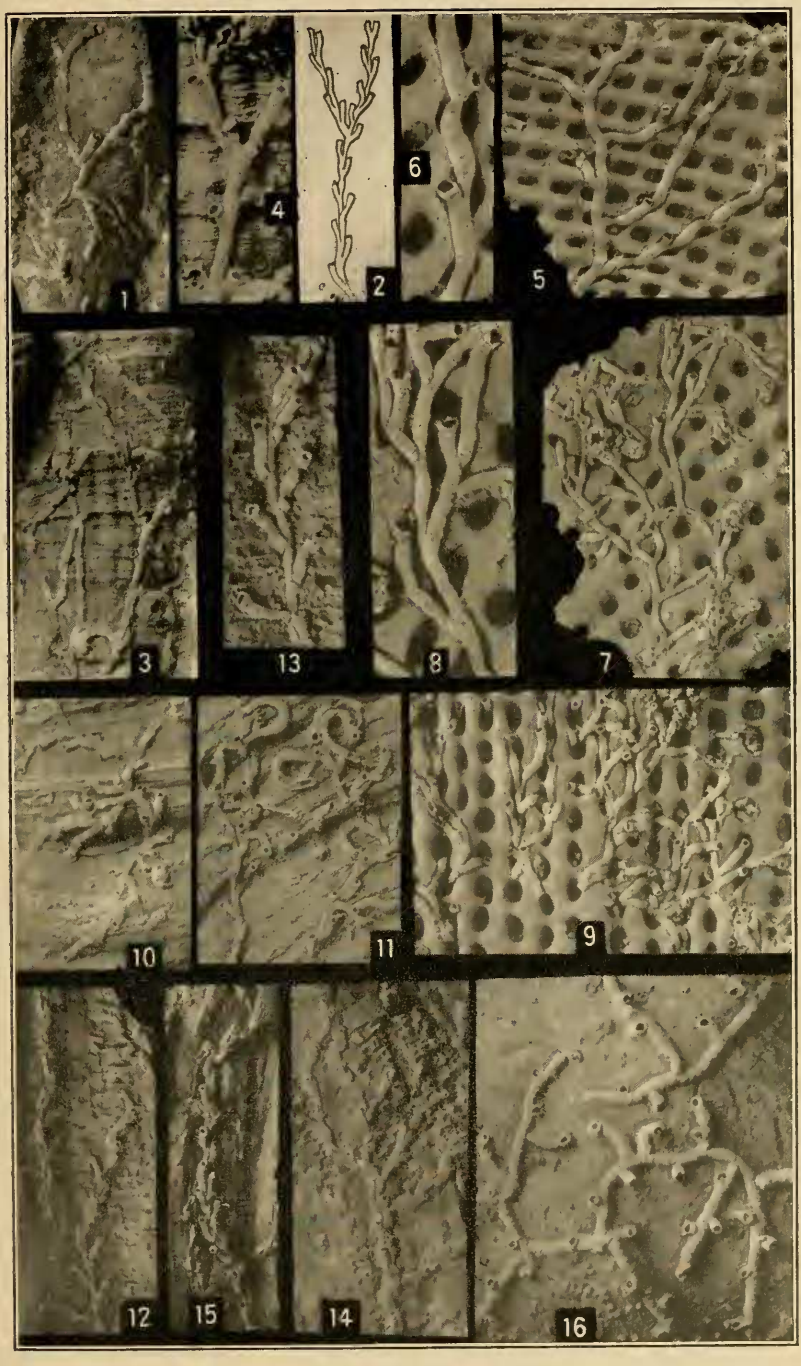
2–4. *Hederella canadensis* (Nicholson, 1874) 31
 2, Nicholson's figure of the Corniferous limestone specimen selected as the holotype.
 3, A topotype identified by Nicholson, showing similarity to *H. cirrhosa* but plainly much smaller.
 4, Portion of the same, × 8.
 Middle Devonian (Onondaga–Deerwville limestone), Port Colborne, Ontario.

5, 6. *Hederella angulata* (Davis, 1885) 40
 The loosely branching zoarium incrusting the noncelluliferous side of a *Fenestrellina*, and a portion, × 8.
 Onondaga (Upper Jeffersonville limestone), Falls of the Ohio.

7–9. *Hederella tenera*, new species 40
 7, 8, The zoarium, and a portion × 8, incrusting the noncelluliferous side of a *Polypora;* the very narrow frequently dividing tubes are characteristic.
 9, Another example in which frequent overlapping of the branches gives a crowded aspect.
 Onondaga (Upper Jeffersonville limestone), Falls of the Ohio.

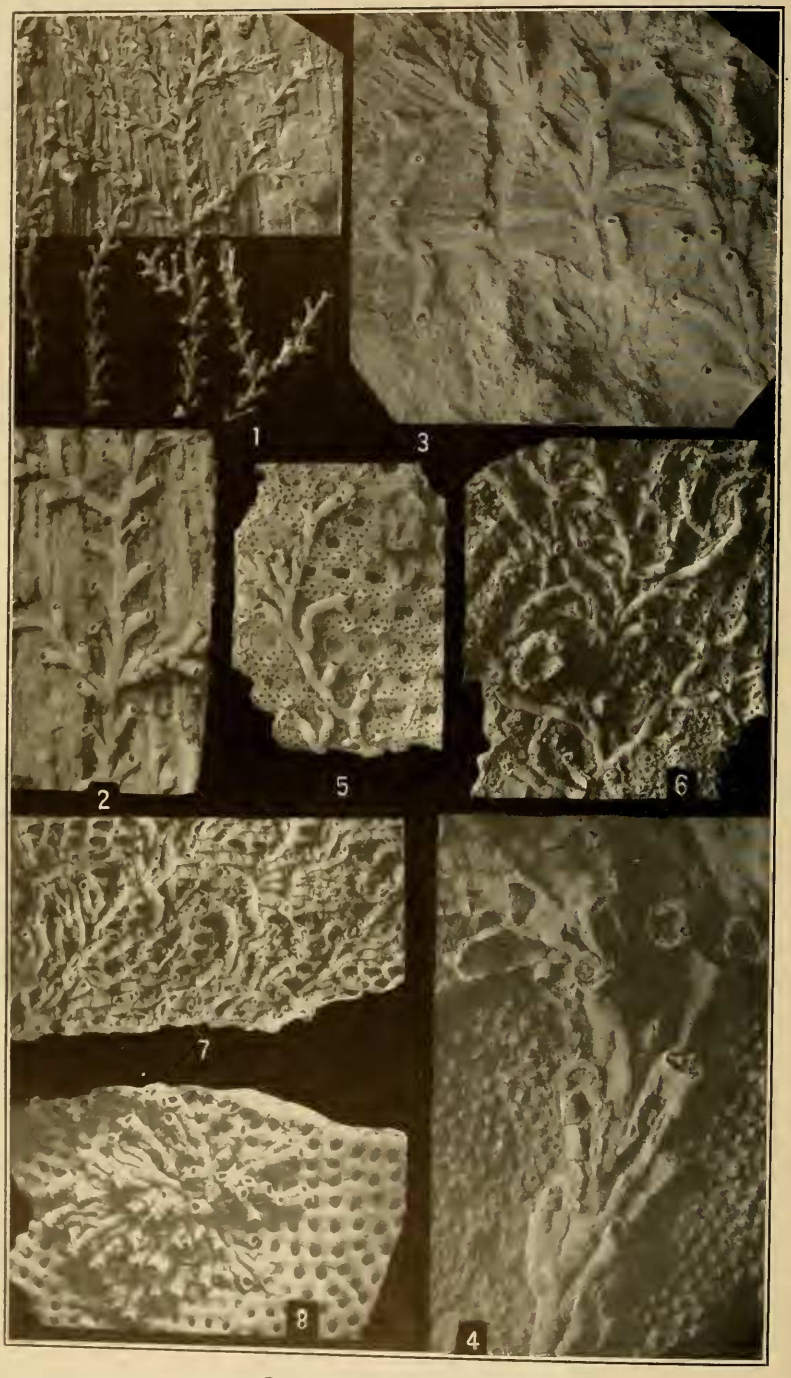
10–15. *Hederella concinna*, new species (see also pl. 15, fig. 2) 32
 10, Young stage of a zoarium, illustrating the ancestrula and the less regularly branching tubes emitted from it.
 Hamilton (Ludlowville–Wanakah shale), Erie County, N. Y.
 11, Another young specimen in which a tendency of the zooecial tubes to coil at their extremity is shown.
 Hamilton (Widder shale), Thedford, Ontario.
 12, Portion of zoarium showing change from young condition to mature stage where the zooecia remain nearly in contact.
 13, Portion of the same, × 8, showing change from youthful to mature arrangement of the tubes.
 14, Portion of a colony illustrating branching of zoarium.
 15, Mature portion of a colony attached to a *Fistulipora*.
 Hamilton (Ludlowville–Centerfield shale), 3 miles west of East Bethany, N. Y.

16. *Hederella rectifurcata*, new species 42
 Zoarium incrusting a coral and illustrating the very short zooecial tubes and the emission of both zooecia and branches at right angles.
 Hamilton (Ludlowville–Wanakah shale), 18-Mile Creek, N. Y.



SPECIES OF HEDERELLA.

FOR EXPLANATION SEE OPPOSITE PAGE.



SPECIES OF HEDERELLA.

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Plate 8

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1, 2. *Hederella regularis*, new species 33

1, The type specimen, a large zoarium incrusting a *Cystiphyllum*, with the background in the lower half blackened to bring out the regular branching and budding of the zooecia.

2, Small portion of same, ×8.

Hamilton (Widder shale), Thedford, Ontario.

3. *Hederella helderbergia*, new species 45

The type specimen, consisting of robust, regularly branching zooecia incrusting a brachiopod shell.

Lower Devonian (Helderbergian–New Scotland limestone), Schoharie County, N. Y.

4. *Hederella major*, new species 53

View of zoarium showing the very large tubes in close contact and the method of branching.

Hamilton (Widder shale), Thedford, Ontario.

5–8. *Hederella contortilis*, new species 39

5, Fragmentary zoarium not complicated by excessive branching.

6, Colony with more complex arrangement of the branches.

7, Colony with the zooecial tubes almost forming a mat.

8, Initial portion of a colony with the specific characters obscured by the tangle of tubes.

Onondaga (Upper Jeffersonville limestone), Falls of the Ohio.

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